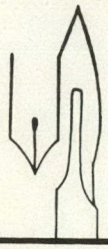
9-1-1985

Volume 28, issue 5

Canadian Medical Association

QUILL ON SCALPEL



This section provides a medium through which Canadian surgeons can declare themselves, briefly and informally, on the day-to-day affairs of surgery.

The Broken Hip

"Breaking a hip" usually refers to fracture of the upper part of the femur through the neck or in the region of the trochanters. In either location, hip fractures present clinical problems that may lead to death or loss of independence for an elderly person. Women are particularly at risk since they are most affected by osteopenia and many of them live alone.

The incidence of hip fractures in North America is approximately 5 per 1000 people between the ages of 70 and 79 years and 20 per 1000 between 80 and 89 years; 71% of victims are women (mean age 73 years).[1]

In a study from the Mayo Clinic,[2] proximal femoral fractures amounted to 30% of all admissions to hospital for fractures and 50% of all days spent in hospital for their treatment.

Several publications from Europe have suggested that there has been a substantial increase in the incidence of hip fractures.[3-5] Melton and colleagues[2] on the other hand have shown that the increase is the result of a larger elderly population. When sex- and age-specific tests are applied, there does not appear to be a rate increase. Any increase in total numbers of fractured hips does, however, imply a need for additional health resources. In Scandinavia, the average hospital stay is 24 days during which the mortality is 8.6%. The mortality at 1 year is 27%. Thereafter, it is similar to that of the normal population.[6]

In Canada, the average length of hospital stay is closer to 12 days but that applies only to acute-care hospitals. The in-hospital stay would increase if convalescent, rehabilitation and chronic-care hospital days were included.

Fractures of the femoral neck within the capsule of the hip joint (subcapital) damage, to a variable extent, the blood supply of the femoral head. If the head dies, it will collapse between 1 and 2 years from the time of fracture. The fracture may in the meantime heal, but the head becomes deformed and the joint painful and stiff. In treating femoral neck fractures, it is most important to reduce the fracture as accurately and as soon as possible if blood flow to the head is to be maintained. The reduction must be held by internal fixation using a device that can adapt to minor shortening of the femoral neck as the fracture settles.

Intertrochanteric fractures on the other hand do not affect the blood supply to the femoral head. They do, however, occur at an angular location in the femur where there are major bending moments. These fractures are unstable — often the thin bone in that region of the femur is shattered. The fracture usually occurs in bones that are moderately or severely osteoporotic. Internal fixation is essential for treatment.

Zukor and colleagues, in this issue (pages 391 to 395), compare two techniques of internal fixation for intertrochanteric fractures. There is little to choose between them: in one technique, the long, curved, steel rods of Ender are introduced through a small port in the lower inner aspect of the femur just above the knee joint. Three to five rods are pushed up the medullary cavity of the femur until their pre-curved leading upper ends are located in the femoral head. The advantage of their use is in the small surgical procedure required, using a wound remote from the fracture site and the patient's groin. There were no operative infections in the reported series of 53 cases. The other technique involves open

The Canadian Journal of Surgery

Le journal canadien de chirurgie

(613) 731-9331

The Canadian Journal of Surgery is published by the Canadian Medical Association and sponsored by the Royal College of Physicians and Surgeons of Canada. The establishment of editorial policy is the responsibility of the Royal College. The objectives of the Journal, endorsed by the Council of the College, are: (1) to contribute to the effective continuing education of Canadian surgical specialists, using innovative techniques when feasible and (2) to provide Canadian surgeons with an effective vehicle for the dissemination of their observations in the area of clinical research.

Published every 2 months by the Canadian Medical Association, PO Box 8650, Ottawa, Ont. K1G 0G8. Printed by Harpell's Press Cooperative, Gardenvale, PQ H0A 1B0. Second-class mail registration No. 5375. Return postage guaranteed. *Subscription rate for Canada and USA $30.00 per year ($15.00 per year for trainees in surgery in Canada only), for all other countries $35.00 per year. Single copies (current issue) available at $5.00 each, back issues at $6.00 each.*

Instructions to Contributors

Detailed instructions to contributors, in English and French, appear on page 95 of the January 1985 issue.

Coeditors
Corédacteurs
L.D. MacLEAN, Montreal, PQ
C.B. MUELLER, Hamilton, Ont.

Senior Associate Editor
Rédacteur associé en chef
D.D. CURRAN

Associate Editor
Rédactrice associée
G. PANCIROV

reduction and internal fixation using a compression screw and a sliding, fixed-angle nail plate. It is a bigger operation, takes longer and, in Zukor's series, was accompanied by infection in seven patients (13.7%), two of whom died.

Why not manage all intertrochanteric fractures with Ender rods? In fact, in Zukor's series there was a higher incidence of reoperation with Ender's rods due to their migration inside the femur, an increased incidence of cardiovascular complications and an increased overall mortality. Not enough experience has been gained to favour one method over the other. Close matching of many more patient pairs is required to draw reliable conclusions.

In the first half of this century and before, breaking a hip was often the last significant physical act in the lives of the elderly. I vividly remember the day George Bernard Shaw fell from a ladder as he pruned an apple tree. His hip broke and he died shortly after that. He was one of many elderly but otherwise well, thinking, productive people for whom, now, a broken hip is an unfortunate and painful incident in life but not necessarily the finale. With present techniques, survival is usual and return to normal living, common.

Two main events have made possible this remarkable change: the development in 1912 of stainless steel and in 1925 the invention of the three-flanged hip nail by Smith-Petersen. The quality and properties of steel have been refined since then. The design of the fixation device and the surgical procedure have greatly improved. With safe anesthesia and bold rehabilitation, the majority of patients no matter how old are returned to their preinjury state. Patients are out of bed within 48 hours, before bed sores, pneumonia and bladder infection develop.

While the treatment of broken hips has improved substantially the prospects for survival and return to normal living, hip fracture is still a dangerous injury. Attempts at reducing the frequency of its occurrence, often from minor trauma, should be directed at the treatment and prevention of its underlying cause, osteopenia of the ageing population.

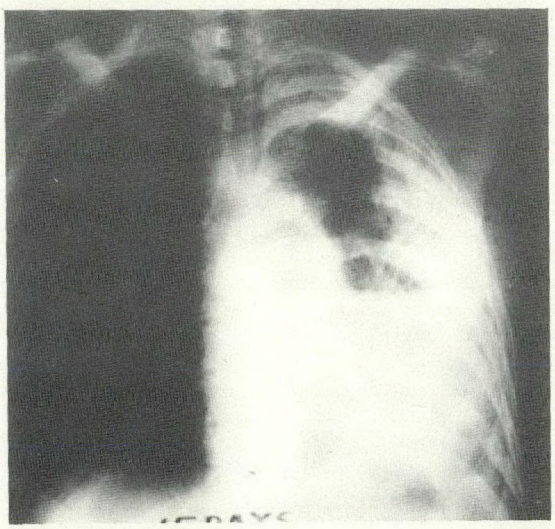
CHARLES SORBIE, MB, CH B, FRCS, FRCSC

Member,
Editorial Board.

Professor and Head,
Department of Surgery,
Queen's University,
Kingston, Ont.
K7L 3N6

continued on page 395

SESAP IV Question



ITEM 247

A man sustains blunt chest trauma causing a pneumothorax and multiple rib fractures. After several sequential tube thoracostomies, the chest roentgenogram shown above is obtained 15 days later. His temperature is now 39.2 C. He has mild pleuritic pain, and the chest tube is no longer draining. The best management would be

(A) a ten-day course of systemic antibiotics
(B) multiple additional chest tubes
(C) thoracotomy and evacuation (decortication) of the pleural cavity
(D) instillation of enzymes via the chest tube
(E) instillation of antibiotics via the chest tube

For the incomplete statement above select the one answer that is best of the five given. For the critique of Item 247 see page 458.

CORRESPONDENCE

Contributions to the Correspondence section are welcomed. They should be written and double spaced.

Penile Dressing After Hypospadias Surgery

To the editors.—A successful result following hypospadias repair, or any penile surgery requiring penile skin flaps or skin mobilization, depends on the following factors among others:

- Adequate tissue vascularity.
- Absence of excessive edema[1,2] postoperatively, since its presence may enhance thrombosis of the small vessels and prevent formation of new vessels to the flap.
- Absence of hematoma[1,2] within the skin flap.
- Adequate immobilization of the penis postoperatively.
- Avoidance of excessive pressure on the tissue due to very tight dressings.

The wide variety of dressings used[1-3] after penile surgery, especially hypospadias repair, suggests the lack of a simple, adequate dressing that will meet most of the criteria. We describe a simple, effective penile dressing for hypospadias repair that we believe may be similarly employed in other reconstructive penile surgery, particularly to reduce edema, bleeding and hematoma.

Technique

Early in the operation, a 2-0 Prolene suture is inserted through the glans penis, with the needle left on; it is used for retraction of the penis. At the end of the surgical procedure, three to four plain gauze dressings are tightly rolled into a cylinder. The cylinder is placed transversely over the suprapubic area behind the dorsal aspect of the penis (Fig. 1). The Prolene suture is passed through the skin of the suprapubic area above the cylinder of dressing so that the penis is hyperextended over the cylinder of the dressing. The tension in the Prolene suture can be varied to maintain hemostasis.

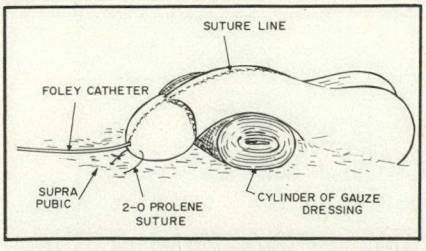


FIG. 1—Penis hyperextended over cylinder of gauze dressings with suture through suprapubic area.

Comments

The advantages of this simple dressing are as follows:

- Postoperative edema is markedly reduced, decreasing morbidity and enhancing primary healing.
- The penis is adequately immobilized, giving the tissues optimal healing conditions.
- Bleeding, especially from the corpora cavernosa, may be further controlled by either increasing the bulk of the cylinder or the tension on the Prolene suture without compromising the surgical suture lines or the skin flaps.
- Since no part of the wound is occlusively covered, it is easy for both the medical and nursing staff to examine and assess the surgical repair.
- Fecal soiling of the dressing, as may occur in children, is completely eradicated.

Penile erections, when they occur with this dressing, may be slightly painful but are not a serious problem.

BENJAMIN A. OKAFO, MD
H.G. KIRULUTA, MD, FRCSC

Health Sciences Centre,
Memorial University of Newfoundland,
St. John's, Nfld.
A1B 3V6

References

1. MATIELAER JJ, BAERT L, VAN DORPE EJ: Silastic foam dressing — the ideal penile dressing. *Urology* 1983; 22: 68
2. CROMIE WJ, BELLINGER MF: Hypospadias dressings and diversions. *Urol Clin North Am* 1981; 8: 545–58
3. FALKOWSKI WS, FIRLIT CF: Hypospadias surgery: the X-shaped elastic dressing. *J Urol* 1980; 123: 904–6

The Military Surgeon

To the editors.—In a recent issue (vol. 28, March 1985, pages 183 to 186), I was pleased to read the article by A. Campbell Derby, entitled "The military surgeon—not least in the crusade".

Regarding the Canadian field surgical team in Korea attached to 8055 MASH for 90% or more of its tour, Dr. Richard Hooker was an American surgeon who wrote the book MASH and wrote under a pseudonym. His proper name is Richard H. Hornberger, and he practises thoracic surgery in Maine. I met him in Toronto at the Mount Sinai Hospital, several years after working with him and other surgeons at MASH 8055. The 25th Canadian field surgical team serving in Korea was commended by General James van Fleet during its tour of duty there, thus:

> Van Fleet wrote that the Canadian unit, which had augmented the surgical section of an American army mobile from May to August, "showed resourcefulness and initiative in integrating themselves into the hospital, working tirelessly for extremely long hours in order that the wounded might receive prompt care".
>
> Attention was given to medical officers Major Charles Egan of Kingston, Major G.G. Lippert of Kitchener and Captain William Crawford of London, Ontario, and also to the enlisted men of the unit.[1]

G.G. LIPPERT, MD, CM, FRCSC, FACS

Ste. 305,
18 Pine St.,
Kitchener, Ont.
N2H 5Z8

Reference

1. Van Fleet praises 25th surgical team, *Kitchener-Waterloo Record*, 1951

Transluminal Angioplasty in Peripheral Vascular Disease

To the editors.—We have read Sheiner's editorial (*Can J Surg* 1985; 28: 193–4), commenting on our article on transluminal angioplasty for advanced peripheral vascular disease (*Can J Surg* 1985; 28: 150–2). First, we do not calculate our initial success rate to be 41%; 70% of

patients had a lessening of symptoms or return of previously absent pulses, or both, after dilatation. Repeat angioplasty was performed in nine patients, but the interval between first and second angioplasty ranged from 2 to 51 months.

Whether the success rate is 41% or 70%, the important issue raised in our article is that dilatation can be successful in many of these high-risk patients with advanced peripheral vascular disease using percutaneous transluminal angioplasty. Morbidity and mortality are low and surgery remains an option.

ROBERT MAGGISANO, MD, FRCSC
BEVERLY A. JONES, MD, FRCSC
ERIC SAIBIL, MD, FRCPC

Sunnybrook Medical Centre,
2075 Bayview Ave.,
Toronto, Ont.
M4N 3M5

Splenectomy for Idiopathic Thrombocytopenic Purpura

To the editors.—The report by Roy, Fortin and Leblond on splenectomy for idiopathic thrombocytopenic purpura (*Can J Surg* 1985; 28: 160–2) appears to present a skewed view of pulmonary complications following this procedure. They report an incidence of 66% for those who had the splenic bed drained versus 20% for those who did not; the overall pulmonary complication rate was 27.5%. A review of complications in a similar group of adult patients with steroid-resistant idiopathic thrombocytopenic purpura in our hospital revealed only one pulmonary complication in 24 cases (4%), in a patient not having drainage postoperatively. I agree that morbidity is increased substantially with drainage of the splenic bed; 5 of 9 patients drained (56%) had a postoperative complication, while only the pulmonary complication was noted in the 15 patients not drained (7%). The complications in our series were deep venous thrombosis, subphrenic abscess, upper gastrointestinal bleeding and wound infection.

Roy and colleagues mention two studies[1,2] in which the pulmonary complication rate was 5.8% and 4.4%; these figures appear more accurate for this complication. The incidence of pulmonary complications is increased following removal of greatly enlarged spleens, as might be expected. Effusion and atelectasis have an incidence of 38% and 21%[3] respectively while there is no increase in the risk of pneumonia.[4]

It would be interesting to know, in Roy's study, the breakdown of pulmonary complications and whether splenomegaly might have affected their pulmonary complication rate. This may well be a more important factor in creating this complication than the presence or absence of a drain.

TIMOTHY WESLEY-JAMES, MD

Resident in Urology,
Ottawa Civic Hospital,
1053 Carling Ave.,
Ottawa, Ont.
K1Y 4E9

References

1. SCHWARTZ SI, HOEPP LM, SACHS S: Splenectomy for thrombocytopenia. *Surgery* 1980; 88: 497–506
2. MINTZ SJ, PETERSEN SR, CHESON B, CORDEL LJ, RICHARDS RC: Splenectomy for immune thrombocytopenic purpura. *Arch Surg* 1981; 116: 645–50
3. GOLDSTONE J: Splenectomy for massive splenomegaly. *Am J Surg* 1978; 135: 385–8
4. WOBBES T, VAN DER SLUIS RF, LUBBERS EJ: Removal of the massive spleen: a surgical risk? *Am J Surg* 1984; 147: 800–2

SURGEONS' UPDATE

What's new in surgery is the subject of this column. The short items are designed to let readers know who's doing what and why. Surgeons are interested in what other surgeons are doing in research, education, practice and administration. Surgery is a vibrant specialty, and, as its practitioners, you must be the source as well as the readers of this column.

Canada Health Act Court Action

Whether or not the legal representatives of the Canadian Medical Association enter a courtroom this month to argue with their counterparts who are acting on behalf of the federal government and the Province of Ontario about the constitutionality of the Canada Health Act and of the province's compliance, new CMA president, general surgeon William J. Vail, of Newmarket, Ontario, says he's not holding his breath about a final decision.

In an interview with CJS, Vail declined to speculate on the implications of winning or losing the historic argument with government, but he alluded to the rationale behind the CMA's action, citing as one of the priorities during his term of office "to ensure or try to ensure that the interests of the members of the profession are protected," particularly when "governments at whatever level interfere with the doctor–patient relationship".

In mid-July, the CMA challenged the federal government's authority to dictate how the provinces must run health insurance programs if they want to draw on federal coffers for part of the costs of care and alleged that the conditions governing the cost-sharing arrangements were inconsistent with the Canadian Charter of Rights and Freedoms. The Association filed a statement of claim in the Supreme Court of Ontario that Ontario — in complying with the Canada Health Act — was impinging on the personal rights of Dr. James McPhee and Ruby Evelyn Kelley. On the one hand, the province requires Ms. Kelley to be a member of the health insurance plan and, on the other, refuses to reimburse her for the costs of health care from McPhee, even though the services are insured under the plan and McPhee is a qualified medical practitioner as defined by the Canada Health Act.

Vail took office just days after Canada's attorney general denied allegations, maintaining that any infringement was within justifiable limits.

Said Vail, "The subject matter is basically out of our hands now as far as making any influence. We've made our decisions and the matter is now a judiciary type of process."

Out of the Association's hands, perhaps, but not far from its thoughts, as Vail's list of priorities showed. During his presidency Vail aims to deal with the issues surrounding the numbers of physicians in Canada and to continue to let the public know that health services are not being adequately funded.

While none of Vail's priorities promises to be free of controversy, he is reasonably comfortable with medical politics. He has been a long-time member of the Ontario Medical Association, has held a variety of offices for the provincial body since the mid-1960s and chaired the board of directors of the national association from 1981 to 1983.

CMA President William Vail

CMA Secretariat to Investigate Organ Shortage

Over the next year, the secretariat of the Canadian Medical Association will be collecting statistics on the numbers of people who are awaiting organs for transplantation and will be investigating ethical means of alleviating any shortage.

The CMA's Committee on Ethics has reported that "there is a recurrent, though implicit, criticism of physicians for failing to persuade relatives to authorize the removal of healthy organs from recent victims of sudden and/or accidental death," and that "when the patient/victim has already manifested his (or her) consent, such as by signing the appropriate portion of his (or her) driver's licence or some other consent form, no other consent is legally required."

Between the lines in the committee's report was the space separating first-contact physicians from surgical specialists on the issue. CMA President Bill Vail as chief of surgery and, since 1963, consulting surgeon for York County Hospital, acknowledged the dilemma of needing vital organs to save lives and of asking a bereaved family for organs from an individual who, though clinically dead, is still alive to them. "I think it's a matter of public relations — in other words, getting you and me as members of the public to know that such situations take place so that when it does happen to us we are better prepared to deal with it. My experience is that most people — most next of kin — are amena-

Contributions to this column are welcome. Please send your material to: Mrs. Amy Chouinard, *Canadian Journal of Surgery,* PO Box 8650, Ottawa, Ont. K1G 0G8.

ble but I have encountered next of kin who are not and they have their own good private reasons.''

Dr. Wilbert J. Keon, director general of the University of Ottawa Heart Institute, agrees but is keenly aware of the restrictions engendered by a shortage of healthy organs. Said Keon, in an interview with CJS, ''The major problem is the reluctance of physicians, out of respect to the grieving family, but there is nobody who can do this as effectively as the family physicians. There is an obligation on the part of all medical practitioners to see that healthy organs are not wasted, given the tremendous success of kidney transplant programs and, to a lesser degree, heart and liver transplants. Our own experience in heart transplantation is a good example. We have done six transplants successfully, and 24 patients expired while on the transplant list. The experience is universal. Vital young people are expiring from single organ disease. One week we had an 18-year-old and a 22-year-old girl expire just because they needed a heart. This is tragic.'' Currently, the institute has eight patients who will die without a new heart — two are too sick to leave hospital.

A look at five healthy people who received another heart to live through Keon's hands clarifies the frustration of knowing that healthy organs are on their way to the grave. At the end of next month, the third recipient, Clive Devereaux, will have survived a year.

A new organization that may be able to play the public relations role envisioned by Vail is called Transplant International. Launched on July 18 at University Hospital in London, Ontario, the organization was the brainchild of Nephrology and Transplant Division chief Calvin Stiller and Bill Brady of CFPL radio. The group will attempt to familiarize people with the concept of being a donor and perhaps encourage them to decide for themselves rather than put the onus on their family at the time of an accident. Anne Lake, the executive coordinator, said that a brochure about the group and a donor card that will satisfy the requirements in all the provinces (currently, the consent forms on driver's licences are not universally accepted) will be available. Before joining Transplant International, Lake worked at a transplantation centre in Toronto. She commented that more than 80% of people say they would donate a family member's organs compared with about 60% who would donate their own. She said families often called the centre after losing a loved one in an accident saying, ''I found the consent form on the driver's licence when I got home. Is it too late to use the organs?'' She maintained that many people have signed the consent forms but not many medical or surgical staff are searching for the forms in emergency rooms. She said the organization will be attempting to reach the public through rotary clubs and other local groups. It will also be publishing a newsletter, ''Transplant Lifeline'', that will focus on the successes in transplantation as well as encourage people not only to donate but to let their relatives know their wishes. Obviously, the more people who make their consent known, the fewer the physicians who will be caught between their colleagues and their patients' families, dodging the label of callousness.

Party celebrated first anniversary of Ottawa's second heart transplant recipient, Daniel Galon (third from left). Others attending party were, from left, Mila Galon (Daniel's mother), Jean-Guy Villeneuve (heart recipient, first anniversary, May 29), Clive Devereaux and Neil Showell (heart recipients) and Ross Davies (cardiologist assisting Keon). In front are Cecile Michaelson (most recent heart recipient) and W.J. Keon.

Manitoba University Head of Surgery Steps Down

After 12 years as head of the Department of Surgery at the University of Manitoba, Allan R. Downs, FRCSC, is embarking on a year of academic leave to pursue research on vascular grafts.

For the next 6 months he will be working with Drs. Jean G. Couture and Robert Guidoin at Laval University, focusing on late complications. He then will spend 3 months at New England Medical Center, Tufts University, Boston, followed by a stint at St. Mary's Hospital in London, England, where he did some of his postgraduate training. He plans to observe and update his knowledge on the investigation and treatment of vascular diseases.

Leaving his position as surgeon in chief at University Hospital, he began his sabbatical immediately, settling into Quebec City by mid-July.

Early this month he was part of the faculty providing a course on peripheral vascular surgery at the annual scientific meeting of the Royal College of Physicians and Surgeons of Canada held in Vancouver, contributing an overview of aortoiliac occlusive disease.

A westerner born in Saskatchewan, Downs joined the University of Manitoba first as an undergraduate, receiving his medical degree there; after completing the McLaughlin travelling fellowship and study abroad, he returned in 1960 as a faculty member. Besides distinguishing

continued on page 458

A.R. Downs, MD, FRCSC

REVIEW ARTICLE

D.J. ZUKOR, MD;* B.J. MILLER, MD, FRCSC;*
A.J. HADJIPAVLOU, MD, FRCSC;* P. LANDER, MD, FRCPC†

Hip Pinning, Past and Present: Richards' Compression-Screw Fixation Versus Ender's Nailing

The authors trace the operative treatment of intertrochanteric hip fractures from the earliest to the most modern methods and describe how current fixation devices evolved. The operative and perioperative morbidity, mortality and outcome in 57 patients treated by Ender's nailing were compared with those of 51 patients treated by Richards' compression-screw fixation. Results were comparable to those found in an extensive review of the literature except for a higher mortality in the group managed by Ender's nailing. The authors conclude that both methods of treatment are acceptable and that the ultimate choice of fixation device should be based on the surgeon's experience tailored to the individual patient's needs.

Les auteurs font l'historique du traitement chirurgical des fractures intertrochantérienne de la hanche, depuis les méthodes les plus anciennes jusqu'aux plus nouvelles, et ils décrivent l'évolution des présents dispositifs de fixation. Les résultats de même que la morbidité et la mortalité opératoires et peropératoires notés chez 57 patients traités par enclouage de Ender ont été comparés avec ceux de 51 patients traités par fixation à l'aide de vis de compression de Richards. Les résultats obtenus étaient comparables à ceux relevés dans une vaste revue de la littérature, sauf pour un taux de mortalité plus élevé dans le groupe traité par enclouage de Ender. Les auteurs concluent que les deux modes thérapeutiques sont acceptables et que le choix définitif du dispositif de fixation doit reposer sur l'expérience du chirurgien par rapport aux besoins individuels des patients.

*From the *Department of Surgery and †Department of Radiology, The Sir Mortimer B. Davis-Jewish General Hospital, McGill University, Montreal, PQ*

Accepted for publication Feb. 26, 1985

Reprint requests to: Dr. B.J. Miller, Ste. 205, 5885 Côte des Neiges, Montreal, PQ H3S 2T2

Hip fractures are a serious problem, taking up ever-increasing amounts of health-care dollars.[1-3] Up to 20% of orthopedic beds are occupied by patients with hip fractures and a recent study estimated the annual cost of treatment in the United States to be $1 billion.[4] The morbidity associated with this fracture is incalculable and the mortality in the first 4 to 6 months after operation is reported to be 12% to 15%.[5-7] Intertrochanteric fractures occur most commonly in postmenopausal, osteoporotic women, due to low-energy injuries such as falling.

Early operation is universally accepted as the treatment of choice of these fractures, in order to avoid the complications of prolonged bed rest (up to 3 months) that would otherwise be necessary.[8] Ironically, it is considered that the need for surgery is inversely proportional to the general medical condition of these usually frail, elderly patients, and that surgery should not be delayed longer than 24 to 48 hours.[9]

Historical Perspective[10]

The technique and internal fixation devices used to manage intertrochanteric fractures have evolved from a crude to a sophisticated level, since Von Langenbeck[11] first reported the use of a nail to fix a fractured hip in 1878. Senn,[12] in 1881, was the first to use a screw, but treatment at that time usually consisted of a body cast, because of the increased dangers of infection and of corrosion or breakage of the implant.

Smith-Petersen's[13] contributions substantially changed the management of intertrochanteric fractures. His incision was refined, making exposure of the fracture site a matter of careful anatomic dissection and his tri-flanged nail (Fig. 1), used initially in 1925, was the first implant expressly designed for the fixation of hip fractures. Johanson,[14] in the hope of reducing avascular necrosis and nonunion, pioneered a technique of closed reduction and blind insertion of the fixation device.

The tri-flanged nail remained in use for almost 50 years but, although it was an excellent device, it alone was not enough to control rotation adequately or prevent the tendency of the femoral head to drift into varus. Also, it tended to "back out" of the bone with subsequent loss of fixation. Thus, Preston introduced a side

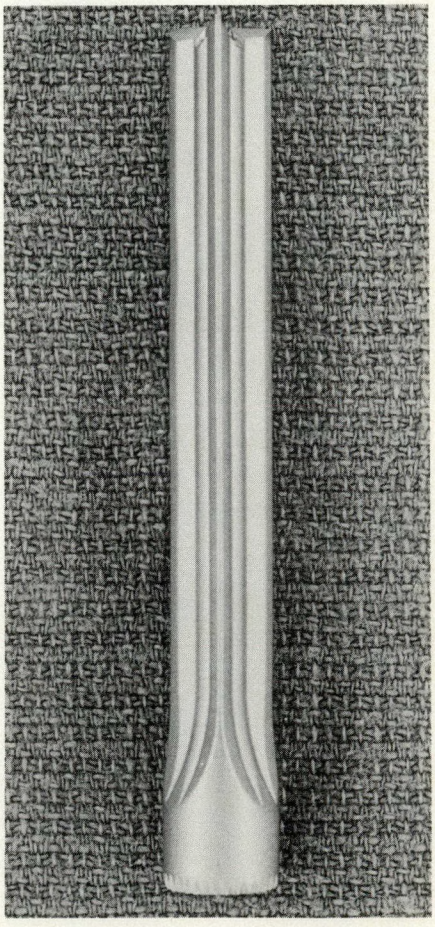


FIG. 1—Tri-flanged nail.

plate to overcome these difficulties.[10] However, this required bending the device to fit the shaft of the femur. Thornton's plate (Fig. 2) was the first attachable to the Smith-Petersen nail and McLaughlin's nail-plate (Fig. 3) eliminated the need for bending because of its variable-angle design.

Another device in use was the one-piece nail designed by Jewett in 1941 (Fig. 4).[15] This became the most popular method of fixing these fractures for nearly 30 years. Then, in 1964, Clawson[16] reported his experience with a new and innovative device, the compression screw and side-plate combination, produced by the Richards Manufacturing Company of Memphis, Tenn. (Fig. 5). This versatile, high-strength system allowed compression of the fracture site at operation, as well as gradual impaction of the fragments with weight bearing. Acting as an internal splint, it sufficiently stabilized the femur to allow early ambulation of the patient, which is precisely the goal of treatment. With these important advantages, the Richards compression system rapidly gained widespread acceptance and remains the current standard of treatment for intertrochanteric fractures in most North American hospitals.

Recently, a "challenger", the condylocephalic nail, has gained popularity in North America (and is already widely used in Europe). Lezius[17] in 1950 was the first to promote the idea of fixing fractures of the trochanteric region by introducing a curved nail from the distal femur. The operative technique is simple, involving minimal exposure of the femur medially, just proximal to the knee. A small cortical window is made and three to five flexible metal rods are introduced into the region of the femoral head, thereby maintaining and sometimes even improving on a previously performed closed reduction. No incision is required in the region of the fracture. Küntscher[18] in 1967 and Harris[19] in 1973 introduced a single semi-rigid nail for this purpose. In 1970, Ender and Simon-Weidner described multiple, flexible pins[20] (Fig. 6). The intramedullary position of the implant allows it to be more medial and therefore closer to the compression side of the femur. This provides a biomechanical advantage as the result is a decreased bending moment of the fixation device.[21,22] Also, "dynamic controlled motion" occurs; this concept, put forth by Pankovich and Tarabishy,[23] describes the favourable amount of motion of the fracture fragments that promotes healing. The net result is early weight bearing for the patient after a simpler, smaller, operative procedure.[24]

Both Richards' compression-screw fixation and Ender's nailing procedures allow early mobilization of the patient. Ender's nailing is a smaller procedure, remote from the fracture site and claims lesser operative morbidity. This attractive advantage stimulated us to carry out a retrospective review and comparison of two similar groups of patients who had undergone either Richards' compression-screw fixation or Ender's nailing for intertrochanteric hip fractures.

Patients and Methods

Between January 1980 and August 1982, 58 Ender's nailings were performed in 57 patients with intertrochanteric fractures (group 1). This group was compared to a group of 51 patients with similar fractures treated by compression-screw fixation between February 1977 and November 1979 (group 2).

Data were obtained from review of the patients' charts and roentgenograms with a follow-up of at least 6 months for all patients. All pathologic fractures were excluded. Fractures were classified and matched according to Tronzo's classification of intertrochanteric fractures.[25]

Variables examined included age, sex, volume of blood lost and transfused,

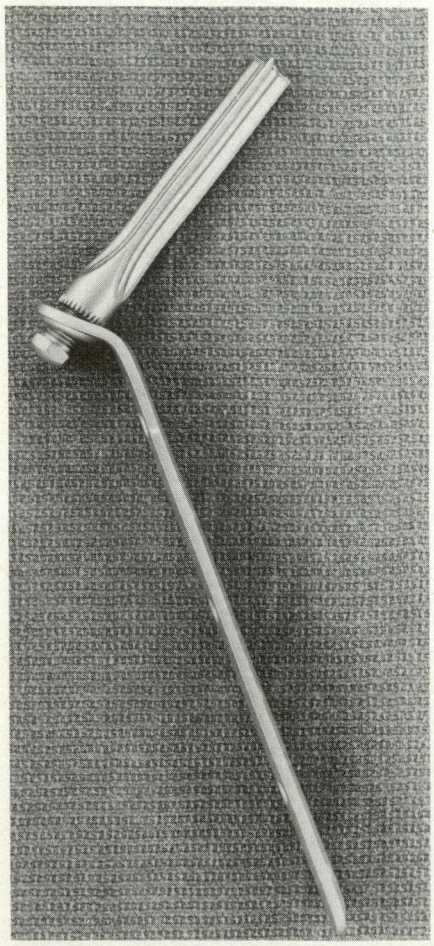


FIG. 2—Nail-plate combination with fixed angle.

FIG. 3—Variable-angle nail-plate combination.

FIG. 4—One piece nail-plate combination.

duration of operation and anesthesia, time to weight bearing, morbidity, mortality and roentgenographic findings at follow-up.

Findings

Fifty-three patients in the Ender's nailing group (group 1) and 51 patients in the Richards' compression-screw group (group 2) were available for study. The mean ages for the two groups were 80.2 and 80.0 years respectively. There were slightly more men in group 2 (Table I).

The duration of both operation and anesthesia was less in group 1 and the amounts of blood lost and transfused were approximately half in this group. Group 1 patients were able to weight bear in similar to slightly less time than group 2 patients (Table I).

Complications

There was only one intraoperative complication, a supracondylar fracture of the femur in a patient who underwent Ender's nailing.

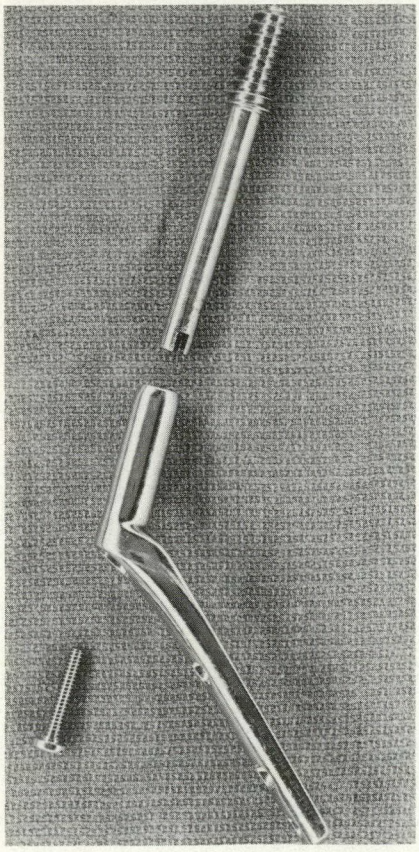
Postoperatively, there was a difference in the infection rate, 13.7% in group 2 compared with 0% in group 1. There were slightly more cardiovascular complications in the Ender's nailing group but a similar incidence of other postoperative problems (Table II).

The number of deaths was somewhat higher in group 1, especially those due to cardiovascular disorders (Table III).

Technical failures again were slightly more frequent in the Ender's nailing group, particularly those due to varus deformity and shortening, but there were no instances of nonunion or implant failure in this group (Table IV).

Discussion

A review of the literature[21-24,26-32] revealed that intertrochanteric fractures fixed with Ender's nails are generally associated with minimal blood loss, a low postoperative complication rate and a low mortality. An increased incidence of external rotation deformity has been reported with Ender's nails but this is not important clinically in elderly patients.[23] On the



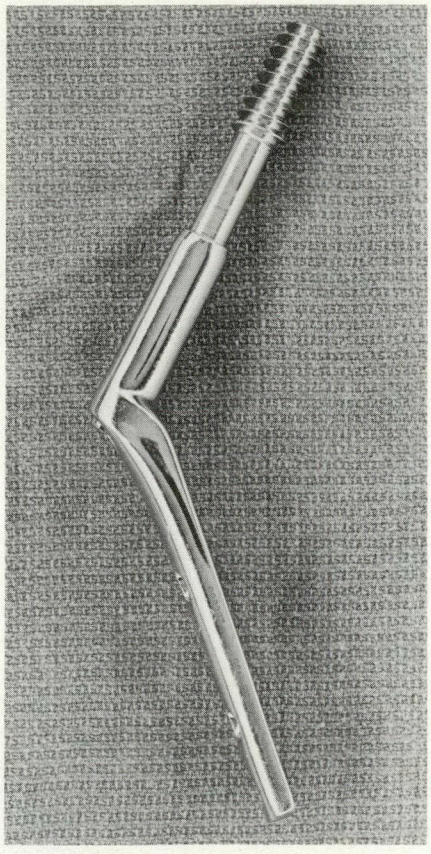


FIG. 5—(Left) Richards' compression screw, showing individual components: threaded lag screw, side plate with barrel, compression screw. (Right) Device assembled.

Table I—Factors Compared

Factor	Group 1 (n = 53)	Group 2 (n = 51)
Age, yr		
Mean	80.2	80.0
Range	52–96	51–95
Male, no. (%)	8 (15.1)	11 (21.6)
Female, no. (%)	45 (84.9)	40 (78.4)
Duration (min) of		
operation, mean (range)	55 (33–145)	81 (40–185)
anesthesia, mean (range)	102 (63–225)	123 (75–245)
Amount (mL) of blood		
lost, mean (range)	233 (100–500)	453 (100–1500)
transfused, mean (range)	241 (0–750)	480 (0–1750)
Time (d) to weight		
bearing, mean (range)	5 (1–11)	7 (1–52)

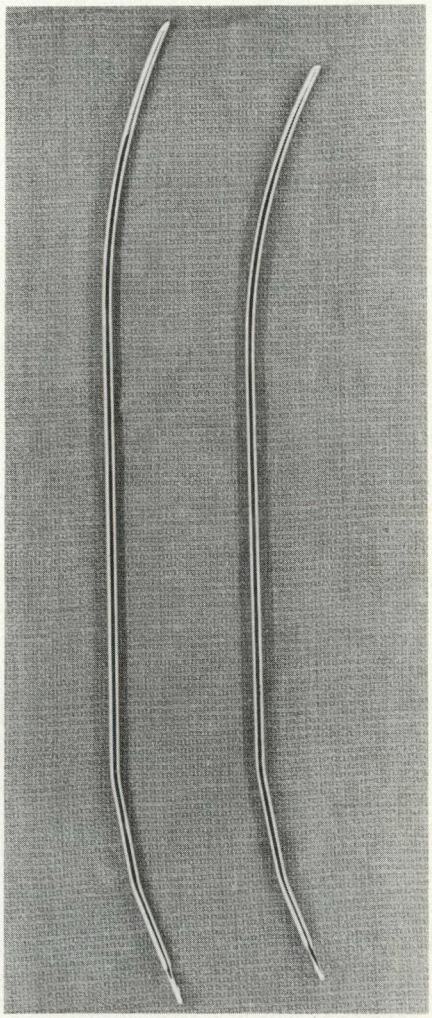


FIG. 6—Condylocephalic "Ender's" nails.

Table II—Postoperative Complications

Complication	Group 1, no. (%) (n = 53)	Group 2, no. (%) (n = 51)
Infectious		
Superficial	0	4 (13.7)
Deep	0	3
Cardiovascular	8 (15.1)	5 (9.8)
Pulmonary	2 (3.8)	2 (3.9)
Thromboembolic	4 (7.5)	5 (9.8)
Gastrointestinal	1 (1.9)	3 (5.9)
Genitourinary	5 (9.4)	7 (13.7)
Miscellaneous	5 (9.4)	2 (3.9)

Table III—Causes of Death

Cause of death	Group 1, no. (%) (n = 53)	Group 2, no. (%) (n = 51)
Sepsis	0	2 (3.9)
Cardiovascular disorders	4 (7.5)	1 (2.0)
Pneumonia	1 (1.9)	0
Cerebrovascular accident	1 (1.9)	0
Chronic lymphocytic leukemia	1 (1.9)	0
Totals	7 (13.2)	3 (5.9)

Table IV—Technical Failures

Cause	Group 1, no. (%) (n = 53)	Group 2, no. (%) (n = 51)
Nonunion	0	1 (2.0)
Proximal migration	1 (1.9)	1 (2.0)
Implant failure	0	1 (2.0)
Varus and shortening	7 (13.9)	2 (3.9)
Totals	8 (15.1)	5 (9.8)

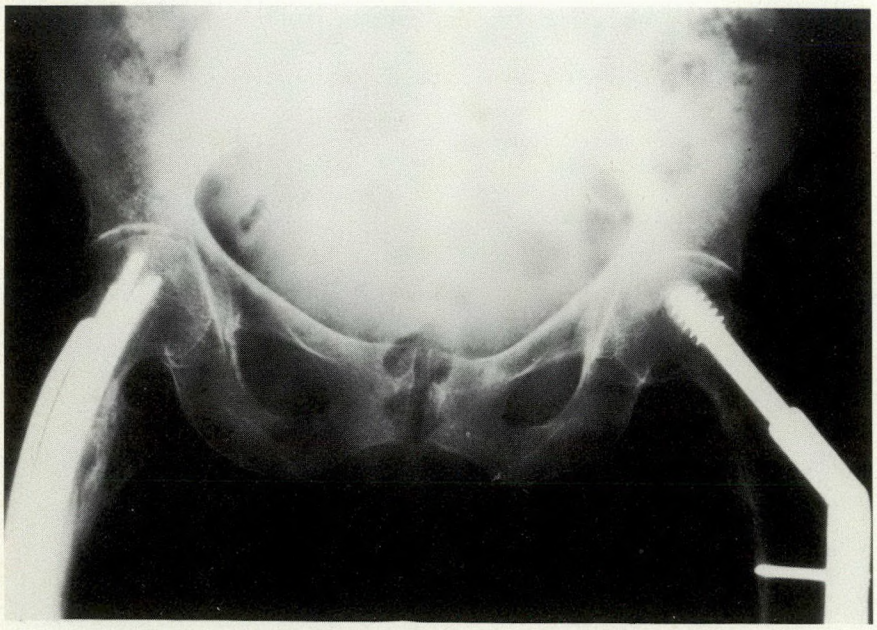


FIG. 7—Patient with bilateral hip fractures treated successfully (on separate occasions) by each method.

other hand, an increased incidence of reoperation after Ender's nailing is reported, due to migration of pins and knee pain. Our study confirmed most of these findings. In addition, we found a slightly increased incidence of cardiovascular complications and a higher mortality than in the group managed by Richards' compression-screw fixation, but this might have resulted from patient selection as some of the surgeons in the study may have chosen the lesser operation for the higher-risk patients.

In considering the technical complications encountered with Ender's nailing, we note that no surgeon had had previous experience with this technique. Complications were highest early in the series and diminished as each surgeon's experience with the procedure increased. In contrast, all surgeons had had considerable experience with the compression-screw method.

Conclusions

Modern technology has provided today's orthopedic surgeon with a wide choice of excellent internal fixation devices. Both Ender's condylocephalic nail and Richard's compression screw achieve the goals of surgical stabilization of the fracture and early mobilization of the patient. On the basis of this study and a review of the literature, no clear-cut superiority of one method over the other could be demonstrated (Fig. 7). Ultimately, the method of treatment chosen should be based on the surgeon's experience, in conjunction with the needs of the individual patient.

References

1. JENSEN JS: Incidence of hip fractures. *Acta Orthop Scand* 1980; 51: 511-3
2. JENSEN JS, TØNDEVOLD E: A prognostic evaluation of the hospital resources required for the treatment of hip fractures. Ibid: 515-22
3. MELTON LJ III, ILSTRUP DM, RIGGS BL, BECKENBAUGH RD: Fifty-year trend in hip fracture incidence. *Clin Orthop* 1982; 162: 144-9
4. OWEN RA, MELTON LJ III, GALLAGHER JC, RIGGS BL: The national cost of acute care of hip fractures associated with osteoporosis. *Clin Orthop* 1980; 150: 172-6
5. JENSEN JS, TØNDEVOLD E: Mortality after hip fractures. *Acta Orthop Scand* 1979; 50: 161-7
6. JENSEN JS, TØNDEVOLD E, SRENSEN PH: Social rehabilitation following hip fractures. Ibid (6 pt 2): 777-85
7. MILLER CW: Survival and ambulation following hip fracture. *J Bone Joint Surg [Am]* 1978; 60: 930-4
8. SHERK HH, SNAPE WJ, LOPRETE FL: Internal fixation versus nontreatment of hip fractures in senile patients. *Clin Orthop* 1979; 141: 196-8
9. EDMONSON AS, CRENSHAW AH: *Campbell's Operative Orthopedics*, 6th ed, Mosby, St. Louis, 1980: 616
10. TRONZO RG: Hip nails for all occasions. *Orthop Clin North Am* 1974; 5: 479-91
11. VON LANGENBECK B: *Verh Deutsch Ges Chir* 1878; 7: 92
12. SENN N: Fractures of the neck of the femur with special reference to bony union after intracapsular fractures. *Trans Am Surg Assoc* 1881; 1: 333
13. SMITH-PETERSEN MN: Treatment of fractures of neck of femur by internal fixation. *Surg Gynecol Obstet* 1937; 64: 287-95

14. JOHANSON S: Zur Technik der Osteosynthese der Fract. colli Femoris. (Vorläufige Mitteilung.) *Zentralbl Chir* 1932; 59: 251–70

15. JEWETT EL: One-piece angle nail for trochanteric fractures. *J Bone Joint Surg* 1941; 23: 803–10

16. CLAWSON DK: Trochanteric fractures treated by the sliding screw plate fixation method. *J Trauma* 1964; 4: 737–52

17. LEZIUS A: Intramedullary nailing of intertrochanteric and subtrochanteric fractures with curved nail. *J Int Coll Surgeons* 1950; 13: 569–72

18. KÜNTSCHER G: A new method of treatment of pertrochanteric fractures. *Proc R Soc Med* 1970; 63: 1120–1

19. HARRIS LJ: Closed medullary nailing of inter and subtrochanteric fractures. *Orthop Trans* 1978; 2: 196

20. ENDER J, SIMON-WEIDNER R: Die Fixierung der trochanteren Buche nit rundir dustichen Condylennageln. *Acta Chir Aust* 1970; 2: 40–2

21. KUDERNA H, BÖHLER N, COLLON DJ: Treatment of intertrochanteric and subtrochanteric fractures of the hip by the Ender method. *J Bone Joint Surg [Am]* 1976; 58: 604–11

22. RAUGSTAD TS, MØLSTER A, HAUKELAND W, HESTENES O, OLERUD S: Treatment of pertrochanteric and subtrochanteric fractures of the femur by the Ender method. *Clin Orthop* 1979; 138: 231–7

23. PANKOVICH AM, TARABISHY IE: Ender nailing of intertrochanteric and subtrochanteric fractures of the femur. *J Bone Joint Surg [Am]* 1980; 62: 635–45

24. EGKHER E, MARTINEK H, PASSL R: Pertrochanteric fractures of the femur. A comparative study of internal fixation with angle nail-plates and flexible condylar nails. *Acta Orthop Scand* 1981; 52: 657–9

25. TRONZO RG: *Surgery of the Hip Joint*, Lea & Febiger, Philadelphia, 1973: 559

26. CHAPMAN MW, BOWMAN WE, CSONGRADI JJ, DAY LJ, TRAFTON PG, BOVILL EG JR: The use of Ender's pins in extracapsular fractures of the hip. *J Bone Joint Surg [Am]* 1981; 63: 14–28

27. JONES CW, MORRIS J, HIRSCHOWITZ D, HART GM, SHEA J, ARDEN GP: A comparison of the treatment of trochanteric fractures of the femur by internal fixation with a nail plate and the Ender technique. *Injury* 1977; 9: 35–42

28. POIGENFÜRST J, SCHNABL P: Multiple intramedullary nailing of pertrochanteric fractures with elastic nails: operative procedure and results. Ibid: 102–13

29. PASSOFF TL, SCHEIN AJ: Ender's flexible intramedullary pins for the treatment of pertrochanteric hip fractures: preliminary report of the first 100 cases. *J Trauma* 1980; 20: 876–9

30. HALL G, AINSCOW DA: Comparison of nail-plate fixation and Ender's nailing for intertrochanteric fractures. *J Bone Joint Surg [Br]* 1981; 63: 24–8

31. OLERUD S, STARK A, GILLSTRÖM P: Malrotation following Ender nailing. *Clin Orthop* 1980; 147: 139–42

32. LEVY RN, SIEGEL M, SEDLIN ED, SIFFERT RS: Complications of Ender-pin fixation in basicervical, intertrochanteric, and subtrochanteric fractures of the hip. *J Bone Joint Surg [Am]* 1983; 65: 66–9

"THE BROKEN HIP"

continued from page 386

References

1. MILLER CW: Survival and ambulation following hip fracture. *J Bone Joint Surg [Am]* 1978; 60: 930–4

2. MELTON LJ III, ILSTRUP DM, RIGGS BL, BECKENBAUGH RD: Fifty-year trend in hip fracture incidence. *Clin Orthop* 1982; 162: 144–9

3. ALFFRAM PA: An epidemiologic study of cervical and trochanteric fractures of the femur in an urban population. Analysis of 1,664 cases with special reference to etiologic factors. *Acta Orthop Scand Suppl* 1964; 65: 1–109

4. BUHR AJ, COOKE AM: Fracture patterns. *Lancet* 1959; 1: 531–6

5. KNOWELDEN J, BUHR AJ, DUNBAR O: Incidence of fractures in persons over 35 years of age: a report to the M.R.C. Working Party on fractures in the elderly. *Br J Prev Soc Med* 1964; 18: 130–41

6. JENSEN JS, TØNDEVOLD E: Mortality after hip fractures. *Acta Orthop Scand* 1979; 50: 161–7

For prescribing information see page 452

A message from Johnson & Johnson on tapes

Dermiclear*

is the highest quality clear tape available because

it was designed for you and your patients.

Dermiclear* is hypo-reactive,

waterproof and provides unobstructed vision for use on I.V. tubes.

It's right for cosmetic dressings.

It stretches and conforms to awkward areas.

Dermiclear* allows moisture release and ventilation,

tears easily in both directions

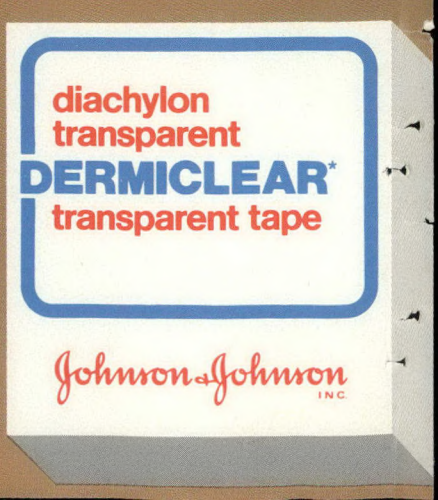
and always unwinds

to the very

JOHNSON & JOHNSON CANADIAN RESEARCH AND DEVELOPMENT ENSURES DERMICLEAR* IS THE HIGHEST QUALITY AVAILABLE.

JOHNSON & JOHNSON TAPES

Doing what they do best



*Trademark of JOHNSON & JOHNSON

MARK E. BOYD, MD, FRCOG, FRCSC

Ectopic Pregnancy

Ectopic pregnancy is no longer dependent on laparotomy for definitive diagnosis. When patients present with massive hemoperitoneum, the diagnosis is usually obvious; but most patients do not present this way, so diagnostic aids are required. Culdocentesis is associated with unusually high false-negative and false-positive results. Laparoscopy is accurate but is an invasive procedure unwarranted in most cases for diagnosis. Although it is unusual to make the diagnosis of unruptured ectopic pregnancy by ultrasonography alone, when ultrasonography is combined with quantitative beta-subunit determinations of human chorionic gonadotropin, many ectopic pregnancies can be diagnosed before rupture occurs. The treatment of the woman with a ruptured ectopic pregnancy and in shock is immediate laparotomy and salpingectomy. Salpingostomy with removal of the ectopic mass and preservation of the tube may enhance a patient's subsequent fertility and may be useful in carefully selected women.

De nos jours, le diagnostic définitif de grossesse ectopique ne dépend plus de la laparotomie. Quand une patiente présente un hémopéritoine massif, le diagnostic, habituellement, ne fait pas de doute. Toutefois, la plupart des patientes n'arrivent pas dans cet état, d'où la nécessité de disposer d'aides diagnostiques. La ponction du cul-de-sac de Douglas donne un nombre anormalement élevé de faux négatifs et de faux positifs. La laparoscopie est exacte mais il s'agit d'une intervention invasive, non justifiée à des fins diagnostiques la plupart du temps. Bien qu'il soit inhabituel d'établir un diagnostic de grossesse ectopique non rupturée par échographie ultrasonique seulement, plusieurs grossesses ectopiques peuvent être diagnostiquées avant rupture quand on associe échographie ultrasonique et détermination quantitative des sous-unités bêta de la gonadotrophine chorionique humaine. Le traitement d'une grossesse ectopique rupturée avec choc nécessite une laparotomie immédiate et une salpingectomie. Dans certains cas bien choisis, une salpingostomie avec interruption de la grossesse ectopique et conservation de la trompe peut améliorer les chances de la patiente de redevenir enceinte.

One hundred years ago, Tait[1] first described the operative treatment of five women who had ruptured ectopic pregnancies. A difficult, cantankerous gynecologist from the English Midlands, Tait described both the diagnosis and treatment of this condition. He commented on the diagnosis in these trenchant words: "Only a fool would await the diagnosis with certainty" and he advised early laparotomy and excision of the uterine appendage. In the succeeding 80 years, diagnosis and therapy have remained essentially unchanged. During the course of this essay, I shall describe the use of new diagnostic aids that permit diagnosis early in the development of the condition before rupture occurs. I shall describe the diagnosis, which does not require recourse to laparotomy. With early diagnosis, surgery that conserves rather than removes the fallopian tube becomes an option. As this article will make clear, there has been notable progress in the treatment of ectopic pregnancies.

From the Department of Obstetrics and Gynecology, Royal Victoria Hospital, McGill University, Montreal, PQ

Accepted for publication Feb. 19, 1985

Reprint requests to: Dr. M.E. Boyd, Department of Obstetrics and Gynecology, Royal Victoria Hospital, 687 Pine Ave. W, Montreal, PQ H3A 1A1

Diagnosis

The most dramatic clinical picture seen on gynecologic wards is that of a patient with a massive hemoperitoneum due to a ruptured ectopic pregnancy. The patient, who is in her reproductive years, presents in shock with a history of abdominal pain and menstrual upset. The diagnosis is clearly that of a ruptured ectopic pregnancy; laparotomy to control the hemorrhage must be undertaken immediately. The need for immediate surgery without delay or attempt at laboratory confirmation cannot be overstated.

However, in developed countries the majority of ectopic pregnancies do not present in this fashion; in the absence of rupture, diagnosis is much more difficult. The symptoms of pelvic pain and menstrual irregularity are nonspecific and the principal physical finding of a pelvic mass is often absent. Unruptured ectopic pregnancies will be diagnosed only when sought, and suspicion alone is not sufficient for definitive diagnosis. Clinically, such disparate conditions as threatened abortion, pelvic inflammatory disease, endometriosis and a variety of medical and surgical conditions mimic ectopic pregnancy.

Since clinical methods alone are unreliable in diagnosing this condition with accuracy, ancillary diagnostic aids are required. The measure of the efficiency of these aids is their ability to diagnose an ectopic pregnancy before rupture occurs and without operative intervention.

Culdocentesis, a technique that involves the insertion of a reasonably wide-bore needle into the cul-de-sac, has been used for many years to assist in diagnosis. However, culdocentesis has fallen into disrepute. Those who oppose the procedure believe that the high false-positive rate (26%) and the frequent absence of blood in the cul-de-sac when the ectopic pregnancy has not ruptured (35%) make the test so unreliable that management is rarely augmented by the findings of the culdocentesis.[2,3] On the other hand, those who do use the procedure point out that the test can be done quickly and with

little discomfort, and thus eliminates the delay and expense of further investigation. Although recent literature supports its continued use, the procedure is seldom performed in our clinic.[4]

Laparoscopy has been suggested as a screening device when the presence of an ectopic pregnancy is suspected.[5] There is no question that laparoscopy can provide accurate diagnosis of various pelvic disorders. Furthermore, its increased use is associated with the ability to diagnose an increasingly large number of ectopic pregnancies before rupture.[6] In spite of its undoubted accuracy, the use of the laparoscope as a screening device is questioned. Even when its use is limited to patients whose positive pregnancy tests make them suspect, nearly one out of every three women will be found to have no ectopic pregnancy.[7] The risk and expense of a frequently unnecessary operative procedure are such that its indiscriminate use for this purpose cannot be recommended. This view must be balanced by the recognition that, when the diagnosis is in doubt, laparoscopy will ease the mind of both the physician and the patient.

In the past few years a laboratory test (beta-subunit pregnancy test) and an echographic technique (pelvic ultrasonography) have radically changed our diagnostic approach to these patients. The beta-subunit pregnancy test is a new and remarkably sensitive pregnancy test.[8] It permits the physician to diagnose pregnancy within 9 days of conception. A negative test rules out the possibility of pregnancy of any sort. This degree of certainty is in contrast to former pregnancy test results, including hemagglutination tests, which all too often gave negative findings when the patient did in fact have an ectopic pregnancy. Human chorionic gonadotropin (HCG) (secreted by placental tissue) consists of an alpha and beta portion. The alpha portion is common to the glycoprotein hormones, follicle stimulating hormone, luteinizing hormone and thyroid stimulating hormone, secreted by the anterior pituitary, whereas the beta portion is specific to placental chorionic gonadotropin. Commercial radioimmunoassay kits are now available that permit such diagnosis within an hour.[9] Furthermore, it is now possible not only to give a qualitative determination of the presence of β-HCG but also to determine quantitatively the precise concentration of β-HCG in the blood. In effect, we can now predict the length of gestation from such blood concentrations. Furthermore, the increasing concentration of β-HCG in early pregnancy can now be determined. The rate of increasing concentration of β-HCG in the circulation is found to vary both with the implantation site and the viability of the pregnancy. When implantation is in the uterine cavity and the pregnancy is normal, the β-HCG level increases by 100% within 2 days.[10] The lower limit of a normal rise is 65%, but in the presence of ectopic pregnancy, the rise is less than 60% (this is true in 87% of the cases). The subnormal production of β-HCG in ectopic pregnancy is thought to be the result of reduced blood supply to the conceptus. Reduced β-HCG secretion may also result from an abnormal pregnancy with a dead or dying trophoblast in a normal intrauterine location, as happens in threatened or missed abortion; these conditions are the most common cause of a falling β-HCG level.

Diagnostic ultrasonography is also most useful in further delineating this vexing clinical problem. There is no question this method can rule out ectopic pregnancy by demonstrating that the pregnancy is intrauterine. In this case, the diagnosis of pregnancy is made by visualization of the fetus itself or, at an earlier stage, the fetal amniotic sac. Although the visualization of the fetus is a definitive sign, there may be some confusion about the diagnosis of an amniotic sac. In some ectopic pregnancies (20%) the ultrasonic picture of the uterine cavity resembles the picture seen in an early pregnancy.[11,12] The usefulness of ultrasonography is further limited because most patients with ectopic pregnancy present early in pregnancy and are often seen before the sac or the fetus would be expected to develop. In such instances, ultrasonography is not helpful. When negative findings are used as the sole indication for diagnostic laparoscopy, an unacceptably high false-positive rate (19%) results.[7,13]

These difficulties can be overcome and the usefulness of ultrasonography greatly increased if the findings on ultrasonography are linked directly to the quantitative level of β-HCG. It has been demonstrated that a normal intrauterine pregnancy can be detected by ultrasonography when the β-HCG concentration is greater than 6000 IU/L.[10,12] This information can be extrapolated further. If the β-HCG is over 6000 IU/L and no intrauterine sac can be seen, then an ectopic pregnancy is likely. On the other hand, if the β-HCG level is less than 6000 IU/L and ultrasonography identifies a sac, the combination would suggest that the pregnancy is a threatened or missed abortion. Although this information is useful, the number of cases where it can initially supply the diagnosis is limited by the fact that ectopic pregnancies normally present with β-HCG levels that are less than 6000 IU/L.[4]

With the above information in mind, the following approach to the diagnosis of ectopic pregnancy is suggested (Fig. 1).

• Is the patient hemodynamically stable? If the patient is unstable and if the clinical diagnosis is that of a ruptured ectopic pregnancy, then laparotomy should be undertaken. Physicians need no reminder that young women tolerate blood loss extremely well and the first and possibly the only sign of vascular instability is tachycardia.

• In all other cases, if the diagnosis is so uncertain that laparoscopy is needed for accurate differentiation, ultrasonography and quantitative β-HCG should be requested instead of proceeding with immediate surgery. A number of diagnostic options will then become available (Table I).

When the location and nature of the pregnancy are uncertain, the β-HCG measurement should be repeated in 48 hours; the results of the second test will make it clear whether one is dealing with a normal intrauterine pregnancy, an ectopic pregnancy or an abortion. In normal cases, the β-HCG will double in 48 hours; in the other circumstances the rise will be less pronounced. The diagnosis of ectopic pregnancy or abortion will be confirmed by curettage followed by laparoscopy if necessary. When intrauterine pregnancy is diagnosed, the diagnosis should be confirmed within a week by diagnostic ultrasonography to rule out

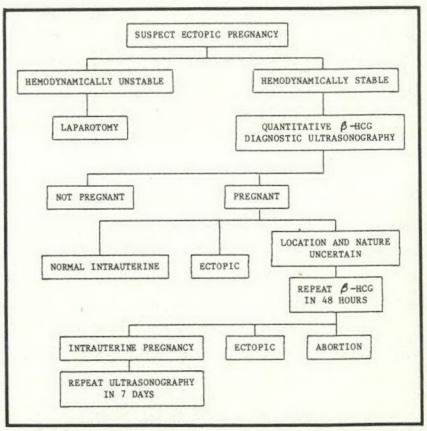


FIG. 1—Suggested approach to diagnosis of ectopic pregnancy.

Table I—Diagnostic Options Outlined by Ultrasonography and Beta-Human Chorionic Gonadotropin (β-HCG) Measurement

Not pregnant
β-HCG < 10 IU/L
Intrauterine pregnancy
Normal intrauterine pregnancy
Fetal heart seen
Intrauterine sac + β-HCG > 6000 IU/L
Abnormal intrauterine pregnancy
Intrauterine sac + β-HCG < 6000 IU/L
Ectopic pregnancy
No intrauterine sac + β-HCG > 6000 IU/L
Complex pelvic mass + β-HCG > 10 IU/L
Nature and location of pregnancy uncertain
No intrauterine sac + β-HCG < 6000 IU/L

those rare cases in which ectopic gestation produces normal β-HCG levels.

Use of this protocol will increase the numbers of ectopic pregnancies diagnosed before rupture and limit the numbers of unnecessary diagnostic laparoscopies.[7] It has made the diagnosis of ectopic pregnancy a more exact science.

Management

In the hemodynamically unstable patient with rupture of the uterine tube, surgery must be undertaken without delay. It may not be possible to resuscitate the patient fully until the bleeding is controlled. It is therefore a grave error to delay surgery while vain attempts are made to raise the patient's blood pressure to normal. The patient is best brought to the operating room immediately. While the patient is prepared for surgery, a bolus of intravenous fluid (Ringer's solution) is given. A lower midline incision is made. The hemoperitoneum is ignored and the surgeon immediately identifies the uterus, which leads the hand to each appendage in turn. If a mass is felt on one side or the other, then that appendage is delivered into the wound. Over 90% of ectopic pregnancies occur in the outer two thirds of the tube and are obvious on palpation. Sometimes no mass is palpated and in this case the uterus itself should be brought into the incision. An ectopic pregnancy may be found in the isthmical portion of the tube. Although these are often small, they are especially dangerous because particularly severe hemorrhage may occur. When the site of the pregnancy has been found, bleeding is controlled by placing Kelly clamps across the mesosalpinx and the cornual portion of the tube. No single tube should be clamped until the other has been visualized and found to be normal. Once the hemorrhage is controlled the patient's condition will improve dramatically. At this point the blood and clot can be aspirated from the peritoneal cavity, peritoneal toilet performed with saline and blood given. The tube may now be removed without haste. The actual technique is relatively unimportant, but may be neatly done if fenestrations are made in the mesosalpinx, and the isolated blood vessels are then clamped and ligated with fine catgut. Cornual resection of the tube is no longer recommended. It is unnecessary; not only does it fail to prevent cornual ectopic pregnancies but may also result in localized myometrial defects that may well compromise a future pregnancy.

In most patients with ectopic pregnancy, salpingectomy is done in a way that is unchanged since Tait's time. Although clearly life-saving, it may fail to prevent other problems that the patient with an ectopic gestation must face in the future. One of these is that following an ectopic pregnancy, one half of the women will not conceive again and 15% are subject to repeat ectopic pregnancy. These disheartening figures have remained constant for some years with the occasional exception in selective reports.[14]

The possibility of improving this poor prognosis was first addressed by Jeffcoate[15] who suggested that the removal of the adjacent ovary would improve the tubal pick-up of the ovum by preventing transperitoneal migration of the fertilized ovum. Although the thinking was ingenious, the results of the procedure have remained both equivocal and controversial and the procedure is no longer recommended. Salpingo-oophorectomy as a treatment for ectopic pregnancy has never been subjected to proper trial.

At present, the thrust of gynecologic thinking is that the outcome of subsequent pregnancies will best be improved by preserving the tube. This will be possible only when the ectopic pregnancy is diagnosed before rupture. What remains controversial, however, is the question of whether such conservative surgery is worthwhile. DeCherney and Kase[16] in a definitive study were unable to show an increased pregnancy rate or a decreased ectopic pregnancy rate. A good case for this surgery may be made for the young woman whose opposite tube is absent or damaged and who wishes to retain her fertility. DeCherney and colleagues[17] described the effect of salpingostomy for unruptured ectopic pregnancy in the presence of one tube only. The absence of the contralateral tube ensures that subsequent pregnancy results from ovum transport through the tube that had had tubal surgery. His results were most worthwhile for women wishing more babies although there was an increased risk of another ectopic pregnancy. The pregnancy rate was 53% and the rate of repeat ectopic pregnancy was 20%. In these special instances, therefore, conservative surgery does seem to be beneficial.

Microsurgery includes linear salpingostomy with a needle cautery, teasing out of placental tissue with fine forceps, immaculate hemostasis with bipolar cautery and the irrigation of the operative area with a heparin solution. The tubal incision may be closed with 6-0 Dexon or left alone with no effort at closure. Postoperatively, RhoGAM is given as required and the level of the β-HCG is monitored at weekly intervals.

Summary

Ectopic pregnancy has become a common surgical emergency. The increased rate of ectopic pregnancy relates to the increased incidence of pelvic inflammatory disease.[18] Both history and physical examination, except in women with tubal rupture, are inconclusive. To diagnose an ectopic pregnancy before rupture of the tube occurs and without invasion of the peritoneal cavity, quantitative β-HCG measurements and diagnostic pelvic ultrasonography are recommended. A diagnostic plan has been outlined. For the most part, surgical therapy is limited to salpingectomy. The very necessary, although limited, place for conservative surgery is also outlined.

References

1. TAIT RL: Five cases of extra-uterine pregnancy operated upon at the time of rupture. *Br Med J* 1884; 1: 1250–1

2. HALPIN TF: Ectopic pregnancy: the problem of diagnosis. *Am J Obstet Gynecol* 1970; 106: 227–36

3. DECHERNEY AH, MAHEUX R: Modern management of tubal pregnancy. *Curr Probl Obstet Gynecol* 1983; 6 (no. 9): 1-38

4. HOLMAN JF, TYREY EL, HAMMOND CB: A contemporary approach to suspected ectopic pregnancy with use of quantitative and qualitative assays for the beta-subunit of human chorionic gonadotropin and sonography. *Am J Obstet Gynecol* 1984; 150: 151–7

5. LINDSTEDT G, LUNDBERG PA, ENK L, REDVALL L: Serum-chorionic-gonadotropin in normal and ectopic pregnancy (C). *Lancet* 1978; 1: 108–9

6. HELVACIOGLU A, LONG EM JR, YANG SL: Ectopic pregnancy. An eight-year review. *J Reprod Med* 1979; 22: 87–92

7. ROMERO R, KADAR N, CHERVENAK FA, DECHERNEY AH, BERKOWITZ RL, HOBBINS JC: Combined use of ultrasound and serum hCG titres in the preoperative diagnosis of ectopic pregnancy (abstr). 29th Meeting of Society for Gynecologic Investigation, Dallas, Mar. 22–27, 1982

8. BRYSON SC: Beta-subunit of human chorionic gonadotropin, ultrasound, and ectopic pregnancy: a prospective study. *Am J Obstet Gynecol* 1983; 146: 163–5

9. GOH BH, MOUNTFORD L, MACKENZIE IZ: A 1-hour hCG radioimmunoassay detection kit for the management of suspected ectopic pregnancy. *Br J Obstet Gynaecol* 1984; 91: 993–6

10. KADAR N, CALDWELL BV, ROMERO R: A method of screening for ectopic pregnancy and its indications. *Obstet Gynecol* 1981; 58: 162–6

11. WEINER C: The pseudogestational sac in ectopic pregnancy. *Am J Obstet Gynecol* 1981; 139: 959–61

12. KADAR N, DEVORE G, ROMERO R: Discriminatory hCG zone: its use in the sonographic evaluation for ectopic pregnancy. *Obstet Gynecol* 1981; 58: 156–61

13. SCHWARTZ RD, DI PIETRO DL: Beta-hCG as a diagnostic aid for suspected ectopic pregnancy. *Obstet Gynecol* 1980; 56: 197–203

14. SHERMAN D, LANGER R, SADOVSKY G, BUKOVSKY I, CASPI E: Improved fertility following ectopic pregnancy. *Fertil Steril* 1982; 37: 497–502

15. JEFFCOATE TNA: Salpingectomy or salpingo-oöphorectomy? *J Obstet Gynaecol Br Emp* 1955; 62: 214–5

16. DECHERNEY AH, KASE N: The conservative surgical management of unruptured ectopic pregnancy. *Obstet Gynecol* 1979; 54: 451–5

17. DECHERNEY AH, MAHEAUX R, NAFTOLIN F: Salpingostomy in the sole patent oviduct: reproductive outcome. *Fertil Steril* 1982; 37: 619–22

18. WESTRÖM L: Effect of acute pelvic inflammatory disease on fertility. *Am J Obstet Gynecol* 1975; 121: 707–13

How do you get a balanced meal through a tube?

isocal*

An excellent choice

To provide a tube-fed patient with a nutritionally balanced diet that is isotonic, lactose-free, has a readily absorbed fat blend and appropriate vitamin and mineral levels, make certain they receive ready-to-feed ISOCAL.

ISOCAL
Complete nutritional value
Problem-free formulation

Mead Johnson CANADA

*T.M. Auth. User

JOSEPH GILBERT SLADEN, MD, FRCSC; JOSEPH L. GILMOUR, MD, FRCSC

Fate of Claudicants After Femoropopliteal Vein Bypass: Prospective, Long-Term Follow-up of 100 Patients

Femoropopliteal bypass grafting for claudication is a controversial procedure. One hundred consecutive patients so treated were analysed for vein-graft patency, subsequent operation and survival. Initial success, treatment of incipient graft failure and attrition from death were the three critical factors influencing long-term benefit. Cumulative graft patency, after revision when necessary, was 89%, 86% and 78% at 2, 5 and 10 years respectively. In assessing the real benefit of surgery in this group, it is important to consider the effect of late deaths, as the life expectancy of these patients is so often shortened by related disease; the "cumulative palliation" (patient alive and graft patent) was 82%, 67% and 28% at the same time intervals. The concept of cumulative palliation sets a high standard in assessing results of vascular surgery, adding important information to the usual graft patency rates that ignore the effect of death. These results suggest a place for femoropopliteal vein bypass grafting in selected claudicants.

Le pontage fémoro-poplité pour la claudication intermittente est controversé. Les dossiers de 100 patients, traités consécutivement par pontage veineux fémoro-poplité pour une claudication importante, furent révisés quant à la permabilité de la greffe, une chirurgie subséquente et la survie du patient. Le succès initial, le traitement d'une thrombose imminente du greffon et l'attrition par le décès furent les trois principaux facteurs qui ont influencé le bénéfice à longue échéance. La permabilité cumulative du greffon, après révision si nécessaire, fut de 89%, 86% et 78%, à 2, 5 et 10 ans respectivement. En évaluant le bénéfice réel de la chirurgie dans ce groupe, il est important de considérer l'effet de la mortalité tardive car l'expectative de vie de ces patients est souvent réduite à cause de maladies associées; "la palliation cumulative" (patient vivant avec une greffe perméable) fut de 82%, 67% et 28%, aux mêmes intervalles. Le concept de palliation cumulative établit un standard élevé dans l'évaluation des résultats de la chirurgie vasculaire en ajoutant une information importante aux taux habituels de permabilité du greffon qui ne tiennent pas compte des décès. Ces résultats suggèrent qu'il y a place pour un pontage veineux fémoro-poplité chez des patients bien sélectionnés, présentant de la claudication.

From the Division of General Surgery, Department of Surgery, University of British Columbia, Vancouver, BC

Presented in part at the 5th annual meeting of the Canadian Society for Vascular Surgery, held in conjunction with the 52nd annual meeting of the Royal College of Physicians and Surgeons of Canada, Calgary, Alta., Sept. 22, 1983

Accepted for publication Apr. 16, 1985

Reprint requests to: Dr. J.G. Sladen, 606-1160 Burrard St., Vancouver, BC V6Z 2E8

Femoropopliteal grafting for claudication is controversial. Linton and Darling[1] published their classic paper on femoropopliteal vein grafts in 1962. Two thirds of their patients had claudication. However, in the succeeding 20 years, results and opinions have varied considerably as to whether this operation is indicated for claudication.[2-4] This study was initiated to assess the long-term result, fate and, more importantly, what was actually achieved in a series of 100 consecutive patients each of whom received a primary reversed femoropopliteal vein graft for claudication.

Patients

Initially, only patients who were unable to work were selected for surgery. Later, we accepted patients whose lifestyle was frustrated by their limitation and who requested surgery on that basis. Each patient suffered symptoms of claudication after walking less than 200 m, 22 were limited to less than 50 m. They were not accepted for operation unless their symptoms had been stable for at least 3 months or were deteriorating. Seven patients had received a femoropopliteal graft previously in the contralateral leg, three had been treated elsewhere for claudication and four by us for ischemia. Ten had undergone aortoiliac "inflow" procedures previously. The mean age of these patients was 60 years (range from 41 to 77 years). There were 30 women. Associated risk factors were standard for arteriosclerotic disease (Table I). Only five patients had never smoked. Of the 121 limbs, 16 had only one patent tibial vessel to the foot, the remainder had two or three. The minimum follow-up was over 5 years for a total of 862 limb-years.

Methods

Starting in July 1964, details of all vascular operations done at St. Paul's Hospital in Vancouver were entered prospectively onto a comprehensive computer form.[5] The first vein graft for claudication was performed in November 1964 and the most recent, in this series, in

Table I—Preoperative Risk Factors in 100 Claudicants Selected for Surgery

Risk factor	No. of patients*
Cardiac disease (includes electrocardiographic abnormalities)	41
Cerebrovascular disease	10
Hypertension	21
Diabetes	10
Plasma triglyceride levels > 2.26 mmol/L	6
Plasma cholesterol level > 7.76 mmol/L	15
Plasma uric acid level > 476 μmol/L	5
Total	108

*35 patients had no identified risk factors.

November 1978. A two-team approach was used; the first author (J.G.S.) was the primary surgeon in all cases, usually in association with the second author (J.L.G.).

Grafts associated with common or superficial femoral endarterectomy, or arising from the superficial femoral artery above the adductor hiatus, were included. The lower end of the vein graft terminated in the popliteal artery above the knee in 44 of the 121 grafts. We were more aggressive in our use of "borderline" vein than we would be today because of our lack of enthusiasm for the alternatives at that time. This probably resulted in more operations for revision. Patients were followed up at 3, 6, 12 and 18 months after surgery, then annually to the time of death or occlusion. None were lost before occlusion, but one patient has been lost to follow-up since the graft occluded. The closing date for this study was Dec. 31, 1984. Absence of symptoms associated with easily palpable pulses was accepted as evidence of graft patency. All patients with grafts of questionable patency underwent femoral arteriography or the graft was considered occluded. The tables of cumulative patency and palliation, risk factors and cause of death were set up initially on an IBM personal computer then confirmed on SPSS.[6]

Results, Fate and Palliation

Primary patency rates at 2, 5 and 10 years were 75%, 68% and 54% respectively (Table II, Fig. 1). Thirty of our 121 grafts had to be revised because of incipient failure — usually stenosis within the first 2 years. Graft patency including the positive effect of these operations (i.e., secondary patency) was 89%, 86% and 78% at 2, 5 and 10 years (Table III). If we assume that the grafts that were revised, all of which were severely stenosed, would have failed at an average of 3 months, then there was a significant statistical gain from the revision ($p = 0.003$, Lee–Desu statistic).

Twenty-one of the 100 patients had a subsequent contralateral femoropopliteal vein graft for claudication and 1 for ischemia. Ten patients had a subsequent inflow procedure and in 7 serious abdominal aneurysms developed. Twenty-five of the 121 grafts thrombosed. Three of these were treated by thrombectomy, but only one was permanently salvaged. In all, five limbs were amputated, all late, two of them within 2 months of the patient's death.

Cumulative survival for the 100 patients was 79% at 5 years and 39% at 10 years. This is compared with the life expectancy curve for 60-year-old persons in Fig. 2. Smoking-related diseases of the vascular and pulmonary systems accounted for 36 of the 42 deaths of known causes (Table IV).

To assess what was actually achieved in this series, we considered a live patient with patent grafts as the criterion for suc-

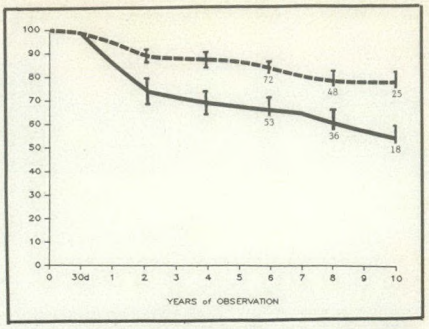


FIG. 1—Cumulative graft patency. Primary patency (solid line) ends with reoperation (revision or thrombectomy), regardless of outcome, and graft failure. Secondary patency (broken line) reflects effect of maintenance operations and ends with graft failure only. Average numbers of limbs at risk during interval are noted below curves which were calculated from limb data base (N = 121).

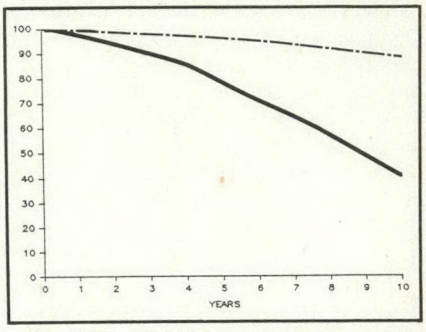


FIG. 2—Cumulative survival of 100 patients after femoropopliteal bypass for claudication (average age 60 years) (solid line) compared to sex-adjusted life expectancy at age 60 (broken line).

Table II—Limb Data Base. Cumulative Primary Patency

Interval start, yr	No. entering interval	No. withdrawn	No. at risk	No. failures	Interval, %		Cumulative success, %	Standard error, %
					Failure	Success		
0	121	0	121	1	1	99	99.2	0.8
30 d	120	4	118	16	14	86	85.7	3.2
1	100	7	96.5	12	12	88	75.1	4.0
2	81	1	80.5	4	5	95	71.3	4.2
3	76	5	73.5	2	3	97	69.4	4.3
4	69	11	63.5	1	2	98	68.3	4.4
5	57	8	53	1	2	98	67.0	4.5
6	48	6	45	1	2	98	65.5	4.6
7	41	10	36	3	8	92	60.1	5.2
8	28	4	26	1	4	96	57.8	5.5
9	23	10	18	1	6	94	54.5	6.1

Table III—Limb Data Base. Cumulative Secondary Patency

Interval start, yr	No. entering interval	No. withdrawn	No. at risk	No. failures	Interval, %		Cumulative success, %	Standard error, %
					Failure	Success		
0	121	0	121	1	1	99	99.2	0.8
30 d	120	4	118	5	4	96	95.0	2.0
1	111	7	107.5	7	7	93	88.8	2.9
2	97	2	96	1	1	99	87.9	3.0
3	94	6	91	0	0	100	87.9	3.0
4	88	11	82.5	1	1	99	86.8	3.2
5	76	9	71.5	2	3	97	84.4	3.5
6	65	6	62	3	5	95	80.3	4.1
7	56	16	48	1	2	98	78.6	4.3
8	39	7	35.5	0	0	100	78.6	4.3
9	32	14	25	0	0	100	78.6	4.3

cess. Thus, patients who had bilateral femoropopliteal bypass grafting for claudication were considered palliated until the first graft occluded or the patient died. On this basis, the palliation rates at 5 and 10 years were 67% and 28% respectively (Table V, Fig. 3). Five patients with patent grafts were to some extent disabled before death (one by stroke, one by renal failure and three by "old age"). Disability is a "soft" end point and accounted for only 7 of a total of 760 patient-years of follow-up. For this reason we used only occlusion and death as criteria for failure of palliation. Each of the following groups was analysed and compared with its counterpart for graft patency and palliation: age older than 64 years and older than 69 years, female, claudication at less than 50 m, single-vessel outflow and the lower end of the graft below the knee. The group with single-vessel outflow fared worst but the difference was not statistically significant in this small sample.

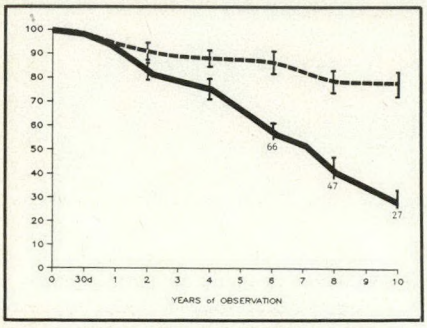


FIG. 3—Secondary graft patency (ability to maintain patent grafts) and cumulative palliation (patient alive and grafts patent) were calculated from patient data base (N = 100). Latter gives critical additional information in assessing patient benefit from operation. Numbers of patients at risk are noted below curve.

Table IV—Causes of Death*

Cause	No. of patients
Cardiac	30
Cerebrovascular (stroke)	6
Vascular	1
Lung cancer	2
Other	7
Unknown	17

*37 alive.

Discussion

Early results in vascular surgery depend upon case selection and technical expertise. There was only one early failure (within 30 days of operation) and no operative deaths in this series. A two-surgeon approach is advocated to shorten the procedure and to allow more flexibility in time if a difficult technical situation is encountered. The graft patency results presented here are surprisingly similar to those of Donaldson and Mannick[4] and appear to be reproducible. The late amputation rate, 0.6% per year at risk, compares favourably with the natural history for claudicants of 1.4% amputations per year[7] but certainly does not, in itself, justify operation.

Selecting claudicant patients for surgery is a challenge, but there are benchmarks. Within 10 years of the onset of symptoms 25% of claudicants will die, the annual mortality from cardiovascular causes being about four times higher than normal.[8] If we select claudicants with angina or those who smoke, the risk of death rises to six or seven times normal.[8] Stated another way, the annual mortality in patients with angina is about 4% and is about 5% after a nonfatal myocardial infarction.[9] However, claudication by itself has little effect on 5-year mortality if we eliminate the cardiovascular risk factors and smoking.[10] We stressed the risk of smoking to our patients and nearly all stopped before surgery. Unfortunately, many resumed the habit but usually at a lower level. Finally, if we are to expand our indications in femoropopliteal surgery to include some claudicant patients, life-style becomes critical. Patients must be selected on their need, wish and ability to lead a more active life.

We did not operate on claudicants with poor outflow. For this reason, graft failure was almost always due to graft-related stenosis. The consequences of femoropopliteal graft occlusion are serious, even when the original grafting was done for claudication.[11] Five of our 25 thrombosed grafts resulted in amputation of the limb. Incipient graft failure must be diagnosed and treated promptly if the graft is to be saved.[12] The hallmarks of graft stenosis are return of claudication, weakening pulses and a bruit over the graft. Patients must be prewarned to report any recurrence of claudication. A drop of 0.2 in the ankle index is serious.[13] The bruit occlusion test[12] is very useful in localizing graft stenosis clinically, and the diagnosis is confirmed by careful angiography.[14]

Reporting results in vascular surgery by the life-table method is mandatory. The standard life table of graft patency is very helpful in comparing grafts, groups of patients or surgeons. Comparing primary and secondary patency rates gives a good indication of the operation's durability. However, as death is dropped out of cumulative patency results, these curves bear little relation to what the surgeon or patient can expect from the operation. Previous reports have stressed the late mortality after peripheral vascular surgery, reporting patient survival and cumulative survival.[15,16] The fact that most of these patients die of related vascular and pulmonary disease is well documented.[10,17] The key to a true reflection of treatment is to combine the cumulative effect of graft failure and death. We have named this curve "cumulative palliation". With the use of in-situ vein grafts, long-term graft patency in the femoropopliteal area may improve, but it is noteworthy that the palliation curve in this series followed the survival curve; 80% of the surviving patients were palliated at 5 years and 70% at 10 years, leaving a relatively small increment to be gained by improved grafting procedures. The concept of "cumulative palliation" is very useful in assessing the success of vascular surgery, adding important information to the usual graft-patency curves which neglect the effect of

Table V—Patient Data Base. Cumulative Palliation

Interval start, yr	No. entering interval	No. withdrawn	No. at risk	No. failures	Interval, %		Cumulative success, %	Standard error, %
					Failure	Success		
0	100	0	100	1	1	99	99.0	1.0
30 d	99	0	99	7	7	93	92.0	2.7
1	92	0	92	10	11	89	82.0	3.8
2	82	0	82	4	5	95	78.0	4.1
3	78	1	77.5	3	4	96	75.0	4.3
4	74	0	74	8	11	89	66.9	4.7
5	66	0	66	9	14	86	57.8	5.0
6	57	4	55	5	9	91	52.5	5.0
7	48	3	46.5	11	24	76	40.1	5.0
8	34	1	33.5	5	15	85	34.1	5.0
9	28	3	26.5	5	19	81	27.7	4.8

death. The fact that about two thirds of these patients were alive with patent femoropopliteal vein grafts 5 years after operation indicates that there is a group of claudicant patients who can be well palliated by this operation. The surgeon's challenge is to identify these patients and keep their grafts functioning.

References

1. LINTON RR, DARLING RC: Autogenous saphenous vein bypass grafts in femoropopliteal obliterative arterial disease. *Surgery* 1962; 51: 62–73
2. STONEY RJ, JAMES DR, WYLIE EJ: Surgery for femoropopliteal atherosclerosis. A reappraisal. *Arch Surg* 1971; 103: 548–53
3. SONNENFELD T: Reconstructive vascular surgery for intermittent claudication. *Acta Med Scand* 1982; 212: 145–9
4. DONALDSON MC, MANNICK JA: Femoropopliteal bypass grafting for intermittent claudication: is pessimism warranted? *Arch Surg* 1980; 115: 724–7
5. SLADEN JG: The personal computer as a clinical research and teaching tool. *Am J Surg* 1984; 147: 654–9
6. NIE NH: *SPSS^X Users Guide*, McGraw, New York, 1983
7. WILSON SE, SCHWARTZ I, WILLIAMS RA, OWENS ML: Occlusion of the superficial femoral artery: what happens without operation. *Am J Surg* 1980; 140: 112–8
8. KANNEL WB, FEINLEIB M: Natural history of angina pectoris in the Framingham study. Progress and survival. *Am J Cardiol* 1972; 29: 154–63
9. PEABODY CN, KANNEL WB, MCNAMARA PM: Intermittent claudication. Surgical significance. *Arch Surg* 1974; 109: 693–7
10. REUNANEN A, TAKKUNEN H, AROMAA A: Prevalence of intermittent claudication and its effect on mortality. *Acta Med Scand* 1982; 211: 249–56
11. WOOSTER DL, PROVAN JL: Fate of the limb after failed femoropopliteal reconstruction. *Can J Surg* 1982; 25: 393–7
12. SLADEN JG, GILMOUR JL: Vein graft stenosis. Characteristics and effect of treatment. *Am J Surg* 1981; 141: 549–53
13. BERKOWITZ HD, HOBBS CL, ROBERTS B, FREIMAN D, OLEAGA J, RING E: Value of routine vascular laboratory studies to identify vein graft stenosis. *Surgery* 1981; 90: 971–9
14. DOWNS AR, MORROW IM: Angiographic assessment of autogenous vein grafts. *Surgery* 1972; 72: 699–707
15. DEWEESE JA, ROB CG: Autogenous venous grafts ten years later. *Surgery* 1977; 82: 775–84
16. SZILAGYI DE, HAGEMAN JH, SMITH RF, ELLIOTT JP, BROWN F, DEITZ P: Autogenous vein grafting in femoropopliteal atherosclerosis: the limits of its effectiveness. *Surgery* 1979; 86: 836–51
17. BEAUCHAMP G, LASSONDE J, LAURENDEAU F, LÉVEILLÉ A: Lung cancer and peripheral vascular surgery. *Can J Surg* 1983; 26: 472–4

N. MCPHAIL, MD, FRCSC; A. MENKIS, MD, FRCSC; A. SHARIATMADAR, M SC; J. CALVIN, MD, FRCPC; G. BARBER, MD, FRCSC; K. SCOBIE, MD, FRCSC; P. WHITE, RN

Statistical Prediction of Cardiac Risk in Patients Who Undergo Vascular Surgery

Since August 1982, an extensive computerized data base has been developed on all patients admitted to the Division of Vascular Surgery at the Ottawa Civic Hospital. For each patient, 180 variables are recorded, including information about preoperative risk factors and postoperative complications. Since cardiac complications are a major cause of mortality and morbidity, the data file has been used to study postoperative cardiac complications in patients who undergo arterial reconstructive operations.

Between August 1982 and December 1983, 353 artery repairs were performed, excluding ruptured aneurysms. Cardiac complications developed following surgery in 56 patients. Risk factors were initially studied using contingency table analysis. Four of these factors were found to be significant: electrocardiographic evidence of previous myocardial infarction (p = 0.0003), non-specific ST-segment changes (p = 0.0007), New York Heart Association classification of symptoms (p = 0.0003) and age (p = 0.01).

A further statistical study was based upon multiple logistic regression. The authors believe that the identification of a high-risk group, using these criteria, is helpful in selecting patients for intensive preoperative investigation, including coronary arteriography.

Depuis août 1982, une vaste banque de données sur ordinateur a été générée à partir de tous les patients reçus au Service de chirurgie vasculaire de l'hôpital Civique d'Ottawa. Ont été enregistrées pour chaque patient, 180 variables dont l'information concernant les facteurs de risque préopératoires et les complications postopératoires. Comme les complications cardiaques représentent une cause majeure de mortalité et de morbidité, le fichier de donnée a été utilisée pour étudier les complications postopératoires chez les patients qui subissent une opération de reconstruction artérielle.

Entre août 1982 et décembre 1983, 353 réparations artérielles ont été effectuées si l'on excepte les ruptures d'anévrisme. Des complications cardiaques postopératoires sont survenues chez 56 patients. Les facteurs de risque ont tout d'abord été étudiés par analyse des tables de contingence. Quatre de ces facteurs se sont avérés importants: les signes électrocardiographiques d'un infarctus du myocarde ancien (p = 0.0003), des modifications non spécifiques du segment ST (p = 0.0007), la classification des symptômes de la New York Heart Association (p = 0.0003) et l'âge (p = 0.01).

Une seconde analyse statistique par régression logistique multiple a été effectuée. Les auteurs croient que l'identification, à l'aide de ces critères, d'un groupe à risque élevé, permet de choisir les patients qui devraient être soumis à un examen préopératoire poussé comprenant une artériographie coronarienne.

Cardiac complications are the commonest cause of death following peripheral arterial reconstruction. If we could reliably identify preoperatively, using simple criteria, the patients most likely to suffer such complications, we might be able to reduce the incidence of cardiac death postoperatively. The present study was carried out in an attempt to predict cardiac risk in patients requiring peripheral arterial repair, using statistical methods.

Method

In 1982 we began an ongoing statistical study of all patients admitted to the Vascular Surgical Service of the Ottawa Civic Hospital. This involved the development of a coded questionnaire containing 180 variables that was filled out on each patient. Following validation, the information was entered into the University of Ottawa mainframe computer, creating a large data base that provided a detailed profile of each patient, includ-

From the Department of Surgery, Department of Cardiology and Department of Research, Ottawa Civic Hospital and University of Ottawa, Ottawa, Ont.

Presented at the 6th annual meeting of the Canadian Society for Vascular Surgery, held in conjunction with the 53rd annual meeting of the Royal College of Physicians and Surgeons of Canada, Montreal, PQ, Sept. 13, 1984

Accepted for publication May 22, 1985

Reprint requests to: Dr. N.V. McPhail, Ste. 310, 1081 Carling Ave., Ottawa, Ont. K1Y 4G2

ing the clinical findings, preoperative investigations, operative procedure and postoperative course. We decided to use this data base to investigate postoperative cardiac complications in patients who underwent peripheral arterial repair.

Potential cardiac risk factors identified for the study were: arteriosclerotic heart disease, diabetes, hypertension, obesity, smoking, hyperlipidemia, previous vascular surgery and age. Assessment of arteriosclerotic heart disease included information about previous documented myocardial infarction, previous coronary artery repair, angina, arrhythmias and electrocardiographic abnormalities. Symptom severity was assessed according to the New York Heart Association (NYHA) classification. Resting admission electrocardiograms were read independently and coded according to the presence of rhythm other than sinus, bundle branch block, evidence of previous myocardial infarction, ST-segment and T-wave changes, and left ventricular hypertrophy. Previous infarction was determined by the presence of Q waves greater than 0.04 seconds in duration and 2 mm in depth. ST-segment depression of 1 mm or more was considered abnormal.

Postoperative cardiac complications studied were: acute myocardial infarction, acute congestive heart failure and arrhythmias requiring treatment. Acute myocardial infarction was diagnosed by electrocardiographic evidence of new ST-segment elevation, corroborated by the finding of elevated cardiac enzyme levels. Congestive failure was diagnosed by clinical evidence of acute pulmonary edema with jugular venous distension or a third heart sound, and by hemodynamic criteria with pulmonary capillary wedge pressure greater than 18 mm Hg and a cardiac index of less than 2.2.

All patients who underwent arterial reconstruction were included except those with ruptured aneurysms. They were excluded since the need for immediate surgery prevented adequate preoperative evaluation of their cardiac status. The study was retrospective, and involved an 18-month period from August 1982 through November 1983.

The results were subjected to statistical evaluation. In the first part of the analysis, we considered each factor individually, and constructed a contingency table to study the relation between each risk factor and postoperative cardiac complications.

Further study focused on all risk factors and attempted to assess the individual and joint effects of the variables. In order to investigate these effects, we fitted a logistic model to the data. The logistic model specified that the probability of cardiac complications depends upon a set of risk factors. The selection of each predictor variable was done by stepwise logistic regression,[1,2] adding those variables to the model that maximized the likelihood of cardiac complications.

Results

During the study period, arterial reconstruction was done in 353 patients; 56 (15.9%) of them suffered cardiac complications and 19 (5.4%) died. Twenty-three suffered myocardial infarction, with 16 (70%) deaths (Table I).

Contingency table analysis indicated that four factors were significant in predicting cardiac risk. These were nonspecific ST-segment changes on the resting electrocardiogram ($p = 0.0007$), electrocardiographic evidence of previous myocardial infarction ($p = 0.0003$), symptom severity as classified by the NYHA ($p = 0.0003$) and age ($p = 0.01$). There were no other significant risk factors. Further analysis was carried out by multiple logistic regression.

ST-Segment Changes

Sixty-one patients had abnormal ST segments on their resting electrocardiogram. Nineteen (31.1%) suffered cardiac complications postoperatively. Thirty-seven of 291 patients with normal ST segments (12.7%) suffered cardiac complications. This difference was significant ($p = 0.0007$). The tracing for one patient was not available.

Myocardial Infarction

The degree of risk involved when there was electrocardiographic evidence of previous myocardial infarction depended upon the location of the infarct (Table II). The risk was greatest when there was evidence of an anterior myocardial infarct (33.3% had complications) or both anterior and inferior infarcts (57.1% had complications).

NYHA Class

The New York Heart Association classification of symptom severity was the third significant predictor of postoperative cardiac complications, the risk being highest for patients with class III symptoms — 33.3% suffered cardiac complications (Table III).

Age

Age was the least important of the significant risk factors ($p = 0.01$) (Table IV). The patients ranged in age from 34 to 94 years. There were no cardiac complications in patients under 40 years of age, and the risk was highest over age 70. The introduction of age as a predictor did not alter the significance of electrocardiographic changes or symptom severity.

In the second part of the analysis, a logistic regression model was fitted to the data. The results of step-wise logistic regression showed that the likelihood of cardiac complications was increased 9% by the presence of ST-segment changes on the electrocardiogram, 10% by evidence

Table I—Postoperative Cardiac Complications

Complication	No.	Survived	Died, no. (%)
Acute myocardial infarction	23	7	16 (70)
Acute congestive failure	5	4	1 (20)
Arrhythmias	21	19	2 (10)
Severe angina and hypotension without myocardial infarction	7	7	0 (0)

Table II—Electrocardiographic Evidence of Myocardial Infarction and Cardiac Complications for 352 Patients*

Electrocardiographic findings	No.	Complications, no. (%)
No infarction	257	33 (12.8)
Inferior myocardial infarction	52	7 (13.5)
Anterior myocardial infarction	36	12 (33.3)
Inferior and anterior myocardial infarctions	7	4 (57.1)

* Tracing for 1 patient was not available.
$p = 0.0003$.

Table III—New York Heart Association Classification and Cardiac Complications

NYHA class	No.	Complications, no.(%)
I	170	25 (14.7)
II	55	15 (27.3)
III	21	7 (33.3)
IV	7	2 (28.6)
0*	99	6 (6.1)

*No symptoms, normal electrocardiogram, 1 patient was not classifiable.
$p = 0.0003$.

of previous infarction, 7% by the NYHA symptom classification and 4% by age. The total number of complications that could be predicted by these four significant variables was thus 30%.

Discussion

The importance of acute myocardial infarction as a cause of death following peripheral artery repair has been well documented by Hertzer.[3] Of 273 consecutive patients who underwent lower extremity revascularization at the Cleveland Clinic between 1969 and 1973, myocardial infarction caused 52% of the early postoperative deaths and 55% of late deaths up to 11 years. Since 1978[4] routine preoperative coronary angiography has been recommended for all patients in his institution who required lower limb arterial repair. Significant correctable coronary artery lesions were found in 54% of patients with aortoiliac disease who had preoperative evidence of coronary artery disease and in 13% of patients with no such evidence.[4] Early results indicated a low risk following preliminary coronary artery repair. In a subsequent report of 1000 patients, presenting with peripheral vascular disease who had coronary arteriography, Hertzer and associates[5] carried out preliminary cardiac procedures in 226, with 12 postoperative deaths (5.3%); 130 of these patients had subsequent peripheral vascular operations and 1 of them died. It has also been suggested by Crawford and associates[6] that the risk of noncoronary operations is decreased following successful coronary bypass surgery.

While careful assessment of cardiac risk is most important before carrying out peripheral vascular reconstruction, the appropriate extent of this evaluation may be difficult to determine in an individual case. All of our patients were assessed clinically by a consultant cardiologist. Recording of one or more resting electrocardiograms was routine. Exercise stress testing was not possible in many patients, since their claudication prevented them from walking far enough on a treadmill to produce cardiac symptoms. Coronary artery catheterization was used selectively, and we are reluctant to advise it as a routine procedure without additional evidence that its use would markedly lower the incidence of postoperative cardiac complications, as well as reduce overall mortality.

Table IV—Age and Cardiac Complications

Age, yr	No.	Complications, no.(%)
< 40	3	0 (0)
40–49	20	2 (10)
50–59	68	3 (4.4)
60–69	122	21 (17.2)
70–79	98	21 (21.4)
≥ 80	42	9 (21.4)

p = 0.01.

Goldman's group[7-9] have produced a good deal of statistical information about cardiac complications following 1001 consecutive operations, subjecting the data to multivariate analysis. Factors that correlated independently with cardiac deaths were: clinical evidence of congestive failure, myocardial infarction within 6 months, rhythm other than sinus or premature atrial contractions on the preoperative electrocardiogram, more than five premature ventricular contractions a minute, significant aortic stenosis, age over 70 years, emergency surgery and type of operation. While Goldman's patients underwent a wide variety of thoracic, abdominal, gynecologic, urologic and breast operations, there were 80 procedures for abdominal aortic aneurysms and he noted an increased cardiac risk following abdominal aortic surgery. The usefulness of Goldman's cardiac risk index has been confirmed by others.[10]

Congestive heart failure preoperatively is known to increase surgical risk, and the increment is proportional to the degree of hemodynamic compromise. Skinner and Pearce,[11] in a study of cardiac patients who underwent general surgical procedures, found that mortality increased directly with the NYHA functional class: class I, 4.3%; class II, 10.6%; class III, 25%; and class IV, 67%. In our patients, the preoperative NYHA classification predicted an increasing number of cardiac complications postoperatively from class I (14.7%) to class III (33.3%). However, only two of the seven patients in class IV (28.6%) suffered cardiac complications. This is at variance with reported data[11] and may be related to the small number of patients in class IV who were operated upon.

The most significant electrocardiographic finding was the presence of signs of previous myocardial infarction of indeterminate age ($p = 0.0003$). The risk of complications depended upon the location of the infarct, being greatest when both anterior and inferior infarction had occurred (58%) and less with anterior (30%) or inferior (14%) infarction alone. History of a remote, clinically documented infarction previously was not significant. The increased risk within 6 months of acute infarction is well known and patients were not operated upon under these circumstances.

The second most important predictor was the presence of nonspecific ST-segment changes ($p = 0.0007$). Goldman noted that nonspecific or nonclassifiable ST changes and flat or negative T waves were associated with an increased postoperative cardiac mortality (4% to 8%) by univariate but not multivariate analysis.[7] T-wave changes were not significant in our series. Age was the least significant predictor of cardiac risk in our patients. The incidence of cardiac complications postoperatively increased from 0% under age 40 to 21.4% among those over age 80. Cardiac risk began to increase at age 60, and was greatest over age 70. A striking increase in patients over 70 years has been reported in a number of other series.[9] It is also of interest in this series to note that age itself did not alter the significance of other predictors (electrocardiographic, NYHA class).

Conclusions

Patients who undergo vascular surgery run a substantial risk of cardiac complications following operation. Among patients requiring peripheral artery repair, it is possible to identify a high-risk group based on routine preoperative electrocardiographic findings, NYHA classification of symptom severity and age. We believe that patients in this high-risk group should undergo intensive cardiologic investigation before operation, including cardiac catheterization and coronary artery repair where appropriate.

References

1. COX DR: *The Analysis of Binary Data*, Methuen, London, 1970
2. MANTEL N, HAENSZEL W: Statistical aspects of the analysis of data from retrospective studies of disease. *J Natl Cancer Inst* 1959; 22: 719–48
3. HERTZER NR: Fatal myocardial infarction following lower extremity revascularization. Two hundred seventy-three patients followed six to eleven postoperative years. *Ann Surg* 1981; 193: 492–8
4. HERTZER NR, YOUNG JR, KRAMER JR, PHILLIPS DF, DEWOLFE VG, RUSCHHAUPT WF III, BEVEN EG: Routine coronary angiography prior to elective aortic reconstruction: results of selective myocardial revascularization in patients with peripheral vascular disease. *Arch Surg* 1979; 114: 1336–44
5. HERTZER NR, BEVEN EG, YOUNG JR, O'HARA PJ, RUSCHHAUPT WF III, GRAOR RA, DEWOLFE VG, MALJOVEC LC: Coronary artery disease in peripheral vascular patients. A classification of 1000 coronary angiograms and results of surgical management. *Ann Surg* 1984; 199: 223–33
6. CRAWFORD ES, MORRIS GC JR, HOWELL JF, FLYNN WF, MOORHEAD DT: Operative risk in patients with previous coronary artery bypass. *Ann Thorac Surg* 1978; 26: 215–21
7. GOLDMAN L, CALDERA DL, NUSSBAUM SR, et al: Multifactorial index of cardiac risk in noncardiac surgical procedures. *N Engl J Med* 1977; 297: 845–50
8. GOLDMAN L: Cardiac risks and complications of noncardiac surgery. *Ann Intern Med* 1983; 98: 504–13
9. GOLDMAN L, CALDERA DL, SOUTHWICK FS, et al: Cardiac risk factors and complications in non-cardiac surgery. *Medicine (Baltimore)* 1978; 57: 357–70
10. ZELDIN RA: Assessing cardiac risk in patients who undergo noncardiac surgical procedures. *Can J Surg* 1984; 27: 402–4
11. SKINNER JF, PEARCE ML: Surgical risk in the cardiac patient. *J Chronic Dis* 1964; 17: 57–72

D.L. WOOSTER, MD, FRCSC, FACS;* R.E. LOUCH, MD, FRCSC;* S. KRAJDEN, MD, FRCPC†

Intraoperative Bacterial Contamination of Vascular Grafts: a Prospective Study

The establishment of graft infection depends on host response, an appropriate field and bacterial contamination. Intraoperative bacterial contamination of prosthetic graft material was studied prospectively in 77 patients. Vascular reconstruction was indicated for abdominal aortic aneurysm (15%), claudication (42%), rest pain (25%) and ulceration or gangrene (18%). In 78% of cases the procedure was elective. *Staphylococcus epidermidis* was isolated in 80% of cultures; mixed flora were more frequent in patients with rest pain (60%) and ulceration or gangrene (45%) than in those with aneurysms (22%) or claudication (16%). Grafts became contaminated in 56% of cases using standard techniques; this was lowered to 35% when the surgeon changed gloves before preclotting the graft. There was no significant difference with respect to the surgeon who performed the operation, the indication for operation, primary versus secondary repair or the use of skin barriers. One patient (1.3%) had an established graft infection. It is concluded that the incidence of contamination is high but may be decreased by glove changing.

L'infection d'une greffe dépend de la réponse de l'hôte, de la présence d'un champ favorable et d'une contamination bactérienne. On a étudié de façon prospective, chez 77 patients, la contamination bactérienne peropératoire d'un greffon prothétique. Il s'agissait de reconstruction vasculaire pour anévrisme de l'aorte abdominale (15%), claudication (42%), douleur au repos (25%) et ulcération ou gangrène (18%). Dans 78%, il s'agissait d'interventions différées. Du *Staphylococcus epidermidis* a été isolé dans 80% des cultures; une flore mixte était plus fréquente chez les patients souffrant de douleur au repos (60%) et d'ulcération ou de gangrène (45%) que chez ceux qui présentaient un anévrisme (22%) ou de la claudication (16%). Avec les techniques conventionnelles, il y a eu contamination du greffon dans 56% des cas. Ce chiffre a été abaissé à 35% lorsque le chirurgien a changé de gants avant la précoagulation du greffon. On n'a constaté aucune différence significative attribuable au chirurgien, à l'indication opératoire, au fait qu'il s'agisse d'une réparation primaire ou secondaire, ou à l'utilisation de barrières cutanées. Un patient (1.3%) a vu l'établissement d'une infection de greffon. On conclut que la fréquence des contaminations est grande mais qu'elle peut être réduite par un changement de gants.

*From the *Department of Surgery and †Department of Microbiology, St. Joseph's Health Centre, University of Toronto, Toronto, Ont.*

Presented at the 6th annual meeting of the Canadian Society for Vascular Surgery, held in conjunction with the 53rd annual meeting of the Royal College of Physicians and Surgeons of Canada, Montreal, PQ, Sept. 13, 1984

Accepted for publication May 21, 1985

Reprint requests to: Dr. D.L. Wooster, Ste. 514, 2425 Bloor St. W, Toronto, Ont. M6S 4W4

Infection of a vascular prosthetic graft is associated with substantial morbidity and mortality that ranges from 25% to 75%, depending on the location of the graft.[1] Those who survive must spend a prolonged period in hospital at considerable cost, many must undergo multiple procedures and 36% to 40% will lose a limb.[2,3] Improved supportive measures, potent broad-spectrum antibiotic therapy and aggressive surgical management have not improved the results in established infections.[2] Despite our awareness of the problem, careful surgical technique and antibiotic prophylaxis, the incidence of graft infection still ranges from 2% to 5%.[1-4]

An appropriate field, a bacterial challenge and the patient's host response are factors in the establishment of a graft infection. The open operative field is clearly unavoidable. Increasingly, patients with an inadequate host response due to age, diabetes mellitus or malnutrition can be recognized and, where possible, their host response can be improved preoperatively. Bacterial contamination may occur in the operating room or in the early or late postoperative period.

Intraoperative contamination of prosthetic graft material was assessed prospectively in this study to address the following questions: What is the incidence of graft contamination intraoperatively? What organisms are involved? Are there identifiable factors associated with contamination? and Can such contamination be minimized intraoperatively?

Patients and Methods

A prospective study was conducted of all patients who underwent vascular reconstruction with a prosthetic graft over an 18-month period at St. Joseph's Health Centre in Toronto. There were 77 patients; 4 were excluded because of incomplete culture collection. Two groups of patients were studied: group 1, 30 patients in whom operative care was routine (i.e., no glove changing) and group 2, 43 patients for whom the operating team changed gloves before preclotting the graft. The indications for surgery included abdominal aortic aneurysm (15%), claudication only (42%), rest pain (25%), gangrene or ulceration, or both (18%) (Table I); secondary procedures or revision surgery were included unless established graft infection was present.

Of the 73 patients forming the study population, 50 (68%) were men. The patients' mean age was 65 years (ranging from 48 to 94 years). Six patients had undergone previous vascular reconstruction. The operations performed included axillofemoral bypass, femorofemoral bypass, aortic tube grafting, aortobifemoral bypass and femoropopliteal bypass. The procedures were elective in 78% and emergency in the remainder. All patients were managed in a standard fashion by two vascular surgeons. All received cefazolin (1 g intravenously) 60 to 90 minutes before operation; no supplemental antibiotics were given systemically or locally during surgery. In elective cases, the skin was shaved using a

blade 12 to 18 hours before operation; in emergency cases, the patient was shaved immediately preoperatively. Skin scrubs were done using povidone iodine. Sterile reusable cloth drapes and gowns were used in all cases. A plastic skin barrier (Op-Site; Smith & Nephew Inc., Lachine, PQ) was used by one surgeon (D.L.W.) for part of the study period. External velour grafts (Meadox Medicals, Inc., Toronto, Ont.) were used; preclotting was performed in a standardized fashion with the patient's own blood using repeated flushing and stripping of the graft.

Cultures were taken from the patient's skin before scrubbing, the surgeon's gloves at the time of glove changing and before preclotting the graft, the dry graft before preclotting, the graft immediately after preclotting and at the last anastomosis. A brain-heart-infusion (BHI) medium was used for all cultures. Specimen handling was supervised by one microbiologist (SK).

Routine in-hospital, clinic and office follow-up for 18 months was used to detect established graft infection.

Statistical evaluation was performed using the paired Student's *t*-test.

Findings

There was no significant difference in age, sex, indication for surgery or operations performed between the two groups.

All skin cultures taken before skin preparation yielded positive cultures. Of these, 80% grew *Staphylococcus epidermidis*. The other 20% grew *Staphylococcus aureus, Staphylococcus saprophyticus,* diphtheroids, anaerobic *Streptococcus*, micrococci, *Klebsiella* sp and *Proteus* sp. The incidence of organisms other than *S. epidermidis* was significantly ($p<0.01$) higher in patients with rest pain (60%) and ulceration or gangrene (45%) than in those with aneurysms (22%) or claudication (16%).

The incidence of graft contamination with the same species of organisms as found on the patient's skin in each study group is shown in Table II. Most contamination occurred at preclotting in both groups, but glove changing decreased the incidence of contamination in group 2 by 10%. The surgeon's gloves were contaminated with the same species of organisms as found on the patient's skin in 53% of cases. Although glove changing lowered the contamination rate at preclotting, ongoing contamination was evident in both groups (Table II).

The incidence of contamination did not differ with either surgical team (37% versus 36.5%) or with the use of the plastic skin barrier (36% versus 37%). A positive culture was obtained in 5 of 14 patients in whom no skin barrier was used and in 6 of 16 with a skin barrier. There was no correlation with the patient's age or sex or with the type or duration of operation. There were no gross breaks in technique in any procedure and no additional concomitant intra-abdominal procedures were performed with the vascular repair.

One established graft infection was identified in follow-up to 18 months. The patient had had three revisions for graft failure before signs of graft infection developed; the offending organism (*S. aureus*) belonged to the same species by biotyping and antibiogram as that cultured at the initial procedure.

Discussion

The incidence of graft contamination with glove changes (25% to 35%) and without (37% to 56%) was remarkably high but the incidence of established graft infection was 1.4%. While long-term follow-up over many years is needed to rule out graft infection, infection from intraoperative contamination should become evident within 18 months of grafting. Cruse and Foord[5] showed baseline infection rates for "clean" operations of 1.81% and for "clean vascular" procedures of 3.7%; few studies report on graft contamination alone. Ernst and colleagues[6] found that in 20% of patients who underwent abdominal aneurysm repair, the bowel bag or aneurysm wall was contaminated, but they did not culture the graft material itself intraoperatively. Blomgren and associates[7] reported that 43% of wounds and prostheses became contaminated during total hip procedures in conventional operating rooms; Lidwell's group[8] found a correlation between airborne contamination and joint sepsis in orthopedic cases. Furthermore, they showed a decrease in joint sepsis with prostheses if contamination was decreased by using "ultraclean air systems".[9] Kluge and colleagues[10] noted similarly high rates of contamination of tissues during cardiac surgery.

Our study reports only the incidence of contamination and, as quantitative studies were not available, we cannot indicate the number of organisms present or if a critical level of contamination was reached. Foreign material has been shown to initiate complex bacteria–graft–host response interactions thereby potentiating infection.[11] Clinical composition, shape and surface characteristics of the graft and mechanical factors may all play a role.[11] Whereas some laboratory models fail to show this potentiation of infection,[2] these results may be misleading due to contrived bacterial challenges[12,13] or excessive numbers of organisms.[14] Bennion and colleagues[14] have shown with small, graduated challenges that different types of grafts have varying patterns of resistance to infection. Clearly, graft material renders normally innocuous bacterial contamination significant and infection by organisms of low pathogenicity may have serious consequences.[6]

Many intraoperative sources of bacteria are present. They include the patient, nurses, surgeons and anesthetists, equipment in the operating room, the operating room air and gross breaks in technique. Contamination from staff is generally episodic and associated with one organism; in this study there was no consistent pattern of contamination despite many personnel and the use of different operating rooms. No gross breaks in technique were identified, no patients were systemically septic and graft cultures correlated well with the flora found on the patients' skin. Therefore, the patient's skin was the most likely source of contamination. This is consistent with the findings of sternotomy infections in cardiac surgery.[15] Further studies, using endonuclease restriction analysis in order to trace the organism from skin to graft, are in progress.

In 80% of samples, *S. epidermidis* was identified; this is consistent with the findings of this organism in 60% of patients in the series of Ernst and colleagues.[6] In our series, the remaining 20% of samples

Table II—Contamination of Graft With Same Organism as Found on Patient's Skin

Cultures obtained	Contamination, %	
	Group 1	Group 2
After preclotting	35	25
At last anastomosis	56	35

Table I—Indications and Operations

Indication/operation	Group 1, no. (%) (n = 30)	Group 2, no. (%) (n = 43)
Aneurysm	7 (23)	5 (12)
Claudication	14 (47)	16 (37)
Rest pain	6 (20)	12 (28)
Ulcer	3 (10)	10 (23)
Aortobifemoral bypass grafting	18 (60)	21 (49)
Extra-anatomic bypass grafting	9 (30)	13 (30)
Femoropopliteal bypass grafting	3 (10)	9 (21)

grew other organisms, which correlated with those cultured from ulcers or skin flora in patients with rest pain. Although it is evident that patients with the gross skin breakdown of ulceration and gangrene will have a more varied flora, the correlation with rest pain in 60% of instances is striking and unexpected; no similar reports are available in the literature. It is proposed that patients in whom perfusion is so borderline as to produce rest pain are susceptible to minor and unnoticed areas of skin breakdown or cracking as well as a decreased immune response, allowing overgrowth of such organisms. This finding may be important when selecting antibiotics for prophylactic use in patients with rest pain. Rather than one drug given routinely to all patients with aneurysm, claudication and rest pain, patients with ulceration should receive prophylactically antibiotics specific to the organisms grown in preoperative cultures. Further studies are in progress to address this issue.

As the incidence of contamination, sometimes with unexpected organisms, is high, are there any factors that can be identified and controlled to limit such contamination? All patients were shaved the night before surgery for elective cases and immediately preoperatively for emergency procedures; there was no difference in the rate of contamination in these two subgroups. We recognize that shaving in the operating room or use of depilatory agents decreases the incidence of infection in clean cases;[5] however, the present series does not address that issue. Routine skin preparation with an effective agent[16] was used in all patients. The use of plastic skin barriers has been implicated in high rates of contamination in orthopedic procedures[7] but in this study there was no difference with or without its use. No special ventilation or "ultraclean air" devices were used.

The incidence of contamination immediately after preclotting using a standard technique of flushing and stripping the graft with their patient's blood was 37%. With glove changing this was reduced to 25%. Ongoing contamination during anastomosis of the graft adds an additional 19% if gloves are not changed and 10% with glove changing. Considerable contamination remains even with glove changing; a "no-touch" preclotting procedure may decrease this but will not eliminate contamination. Other graft handling changes such as protecting the graft from contact with the skin edge or other tissues may decrease contamination but were not studied here.

It is unlikely that all bacteria will ever be excluded from intraoperative contact with a graft, hence antibiotics should be used prophylactically. Antibiotics given before surgery and for a brief period after have been shown to decrease the incidence of wound infections and pneumonia.[2,11,15,17] Szilagyi and associates[3] and Fry and Lindenauer[18] have shown low incidences of graft infection with no antibiotics and Fry and Lindenauer[18] found no difference with antibiotics. Kaiser and associates[16] in a randomized double-blind study showed a decrease in all infections with antibiotics; all graft infections occurred in the group not given antibiotics. Antibiotic soaks and topical agents are ineffective.[2] Recent animal studies with antibiotic bonded grafts show good protection against infection in experimental settings with Dacron,[19] human umbilical vein[14] and polytetrafluoroethylene.[20] The selection of the best antibiotic for such grafts is still under study.

In view of the high incidence of contamination of vascular grafts with the standard operative technique, antibiotics should be given prophylactically. Methods to decrease contamination by variations in operative technique are being investigated.

Conclusions

This study demonstrated a high incidence of contamination of prosthetic material during vascular reconstructive surgery. This contamination is independent of the indication for surgery, whether a primary or secondary repair is performed, the surgeon involved, the skin preparation used and the use of plastic barriers. The organisms identified are consistent with the patient's skin flora and may include a wide range of organisms in patients with rest pain or ulceration. Contamination occurs prominently at preclotting and can be decreased but not controlled by changing gloves. Ongoing contamination occurs throughout the handling and placement of the graft. Antibiotics should be used in an attempt to control established infection due to this contamination.

References

1. CASALI RE, TUCKER WE, THOMPSON BW, READ RC: Infected prosthetic grafts. *Arch Surg* 1980; 115: 577–80
2. BUNT TJ: Synthetic vascular graft infections. I. Graft infections. *Surgery* 1983; 93: 733–46
3. SZILAGYI DE, SMITH RF, ELLIOTT JP, VRANDECIC MP: Infection in arterial reconstruction with synthetic grafts. *Ann Surg* 1972; 176: 321–33
4. YASHAR JJ, WEYMAN AK, BURNARD RJ, YASHAR J: Survival and limb salvage in patients with infected arterial prosthesis. *Am J Surg* 1978; 135: 499–504
5. CRUSE PJ, FOORD R: A five-year prospective study of 23,649 surgical wounds. *Arch Surg* 1973; 107: 206-10
6. ERNST CB, CAMPBELL HC JR, DAUGHERTY ME, SACHATELLO CR, GRIFFEN WO JR: Incidence and significance of intra-operative bacterial cultures during abdominal aortic aneurysmectomy. *Ann Surg* 1977; 185: 626–33
7. BLOMGREN G, HAMBRAEUS A, MALMBORG AS: The influence of the total body exhaust suit on air and wound contamination in elective hip-operations. *J Hosp Infect* 1983; 4: 257–68
8. LIDWELL OM, LOWBURY EJ, WHYTE W, BLOWERS R, STANLEY SJ, LOWE D: Airborne contamination of wounds in joint replacement operations: the relationship to sepsis rates. Ibid: 111–3
9. Idem: Effect of ultraclean air in operating rooms on deep sepsis in the joint after total hip or knee replacement: a randomized study. *Br Med J* 1982; 285: 10–4
10. KLUGE RM, CALIA FM, MCLAUGHLIN JS, HORNICK RB: Sources of contamination in open heart surgery. *JAMA* 1974; 230: 1415–8
11. DOUGHERTY SH, SIMMONS RL: Infections in bionic man: the pathobiology of infections in prosthetic devices. Part I. *Curr Probl Surg* 1982; 19: 217–64
12. BAKER WH, BODENSTEINER JA: The administration of antibiotics in vascular reconstructive surgery. A comparison of systemic cephaloridine versus cephaloride-soaked grafts in preventing graft infections in dogs. *J Thorac Cardiovasc Surg* 1972; 64: 301–3
13. FOSTER JH, BERZINS T, SCOTT HW JR: An experimental study of arterial replacement in the presence of bacterial infection. *Surg Gynecol Obstet* 1959; 108: 141–8
14. BENNION RS, WILLIAMS RA, WILSON SE: Comparison of infectibility of vascular prosthetic materials by quantitation of median infective dose. *Surgery* 1984; 95: 22–6
15. AUSTIN TW, COLES JC, BURNETT R, GOLDBACH M: Aortocoronary bypass procedures and sternotomy infections: a study of antistaphylococcal prophylaxis. *Can J Surg* 1980; 23: 483–5
16. KAISER AB, CLAYSON KR, MULHERIN JL, ROACH AC, ALLEN TR, EDWARDS WH, DALE WA: Antibiotic prophylaxis in vascular surgery. *Ann Surg* 1978; 188: 283–9
17. PERDUE GD JR: Antibiotics as an aid in the prevention of infections after peripheral arterial surgery. *Am Surg* 1975; 41: 296–300
18. FRY WJ, LINDENAUER SM: Infection complicating the use of plastic arterial implants. *Arch Surg (Chicago)* 1967; 94: 600–9
19. MOORE WS, CHVOPIL M, SEIFFERT G, KEOWN K: Development of an infection-resistant vascular prosthesis. *Arch Surg* 1981; 116: 1403–7
20. GRECO RS, HARVEY RA, SMILOW PC, TESORIERO JV: Prevention of vascular prosthetic infection by a benzalkonium-oxacillin bonded polytetrafluoroethylene graft. *Surg Gynecol Obstet* 1982; 155: 28–32

BOOKS RECEIVED

This list is an acknowledgement of books received. It does not preclude review at a later date.

The Acute Abdomen. Diagnosis and Management. John R. Kirkpatrick. 300 pp. Illust. Williams & Wilkins, Baltimore, 1984. Price not stated. ISBN 0-683-04618-7.

Anatomy as a Basis for Clinical Medicine. E.C.B. Hall-Craggs. 658 pp. Illust. Urban & Schwarzenberg, Baltimore, 1985. $36.(US). ISBN 0-8067-0871-9.

Angina Pectoris. 2nd ed. Edited by D.G. Julian. 233 pp. Illust. Churchill Livingstone, Edinburgh; Academic Press Canada, Don Mills, 1985; $73. ISBN 0-443-02269-0.

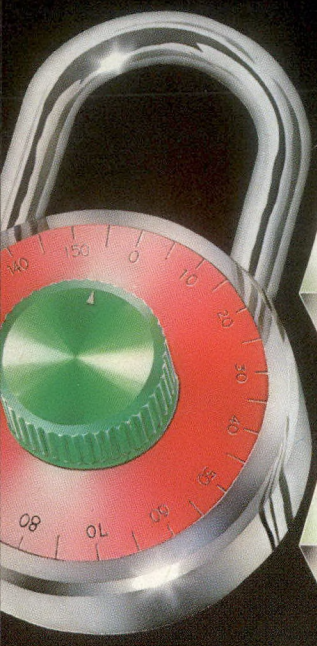
Arterial Surgery. Clinical Surgery International. Vol. 8. Edited by John J. Bergan. 231 pp. Illust. Churchill Livingstone, Edinburgh; Academic Press Canada, Don Mills, 1984. $55. ISBN 0-443-02763-3.

Carcinoma of the Large Bowel and Its Precursors. Proceedings of a Conference Held in Detroit, September 27-28, 1984. Edited by John F.R. Ingall and Anthony J. Mastromarino. 305 pp. Illust. Alan R. Liss, Inc., New York, 1985. $48.(US). ISBN 0-8451-5036-7.

Cardiac Surgery: A Looseleaf Workbook and Update Service. Donald B. Doty. Illust. Year Book Medical Publishers, Inc., Chicago, 1985. Price not stated, looseleaf binder. ISBN 0-8151-2760-X.

Cataract Surgery. Ophthalmology 2. Edited by Arthur D. McG. Steele and Robert C. Drews. 383 pp. Illust. Butterworth & Co. (Publishers) Ltd., Boston, 1984. $109.95(US). ISBN 0-407-02341-0.

continued on page 411



They work so well together...

ANUSOL-HC AND TUCKS

An effective combination to relieve the pain and itch of hemorrhoids and other anorectal disorders

- Relieves pain, itch and inflammation
- Lubricating petrolatum base
- Colorless ointment and suppositories

- Soothing medicated cleansing pads
- Prevents mechanical irritation from toilet tissue
- Helps promote proper hygiene

PARKE-DAVIS

Parke-Davis Canada Inc., Scarborough, Ontario

PAAB CCPP

*Reg. T.M. Parke, Davis & Company, Parke-Davis Canada Inc., auth. user

PMAC

Symposium on the Controversial Aspects of Colonic and Rectal Carcinoma

Introduction

Carcinoma of the large bowel is one of the most common visceral malignant lesions seen in the West. Worldwide incidence is also high with geographic variations. In North America, the age-adjusted mortality per 100 000 population shows the highest rates in Canada (19.5), followed by the United States (17), then Mexico (2.9). The diagnosis and management of patients affected with carcinoma of the large bowel is therefore of great concern to physicians and surgeons in these countries.

This symposium has brought together a distinguished panel of speakers to share with us their practice and recommendations in dealing with this common carcinoma.

There is a saying that we should learn from the mistakes of others, for we cannot live long enough to make them all ourselves. This adage should be paraphrased for our panel of specialists so that "we should learn from the experiences of others for most of us as general surgeons cannot have the volume or live long enough to have them all ourselves".

Our first speaker, Professor John Goligher, is well known for his many articles and his up-to-date complete textbook, "Surgery of the Anus, Rectum and Colon". Professor Goligher will present a paper on sphincter-saving operations for rectal carcinoma.

Surgery must still be the principal treatment for malignant tumours of the large bowel. The 5-year survival rates have not really improved over the past 30 years. Technically, surgery may have advanced as far as it can, so we require other modalities to assist us in extending treatment. The word "adjuvant" is defined as assisting, aiding or assisting another. Dr. Norman Wolmark's paper on the role of adjuvant chemotherapy in colorectal carcinoma will help to do that.

The first two contributors deal with what is hoped, initially, to be a curative approach to colonic and rectal carcinoma. To deal with the real spectre of recurrence of the disease, which will occur in approximately 50% of patients, regardless of stage, Dr. Bernard Langer will present his views and recommendations on the management of metastatic disease secondary to colorectal carcinoma and Dr. Alfred Ketcham will discuss the management of recurrent rectal carcinoma.

We know that in 50% of patients who have recurrent disease after an operation for cure, the recurrence will appear in the first 18 months and the remainder within 4 to 6 years of the operation. Since there is approximately 50% 5-year survival, regardless of stage, how can we tell which patients will have recurrent tumour? This places a considerable commitment for after-care and follow-up on the physician and patient alike. Dr. James Langevin of Calgary will tell us what he considers to be the appropriate follow-up for patients with colorectal carcinoma.

ROBERT H. THORLAKSON, MD, FRCS, FRCSC, FACS

Symposium chairman

Professor of Surgery,
University of Manitoba,
Winnipeg Clinic,
Winnipeg, Man.
R3C 0N2

BOOKS RECEIVED

continued from page 409

Chirurgie 84. Résumés des travaux scientifiques présentés au 86e congrès français de chirurgie, Paris, 24 au 27 septembre 1984. Association française de chirurgie. Textes publiés sous la direction de M. Malafosse. 139 pp. Masson, Paris, 1984. Prix non mentionné, broché. ISBN 2-225-80397-8.

Clinically Oriented Anatomy. 2nd ed. Keith L. Moore, 101 pp. Illust. Williams & Wilkins, Baltimore, 1985. $38.50(US). ISBN 0-683-06132-1.

Colon and Rectal Surgery. Marvin L. Corman, 784 pp. Illust. J.B. Lippincott Company, Philadelphia, 1984. $85 (US). ISBN 0-397-60647-3.

Current Concepts of Infections in Orthopedic Surgery. Edited by Hans K. Uhthoff and Elvira Stahl. 300 pp. Illust. Springer-Verlag, New York, 1985. $48.50(US). ISBN 0-387-13560-X.

Dr. Kathryn Schrotenboer's Guide to Pregnancy Over 35. Kathryn Schrotenboer and Joan Solomon Weiss. 244 pp. Ballantine Books, New York, 1985. $10.75, paperbound. ISBN 0-345-31347-X.

Fluids and Electrolytes in the Surgical Patient. 3rd ed. Carlos Pestana. 245 pp. Illust. Williams & Wilkins, Baltimore. 1985. $18.95, paperbound. ISBN 0-683-06861-X.

Fractures of the Pelvis and Acetabulum. Marvin Tile. 256 pp. Illust. Williams & Wilkins, Baltimore, 1984. $48.50 (US). ISBN 0-683-08249-3.

Les greffes de la peau. Biologie et technique. Robert Amar et Bernard Dessapt. 118 pp. Illust. Masson, Paris, 1985. Prix non mentionné. ISBN 2-225-80374-2.

Handbook of Regional Anesthesia. Edited by P. Prithvi Raj. 285 pp. Illust. Churchill Livingstone, Edinburgh; Academic Press Canada, Don Mills, 1985. $58. ISBN 0-443-08285-5.

Illustrated Guide to Surgical Practice. Joseph Freidin and Vernon Marshall. 241 pp. Illust. Churchill Livingstone, Edinburgh; Academic Press Canada, Don Mills, 1985. $26.50, paperbound. ISBN 0-443-02628-9.

Labat's Regional Anesthesia. Techniques and Clinical Applications. 4th ed. John Adriani. 728 pp. Illust. Warren H. Green, Inc., St. Louis, 1985. $75(US). ISBN 0-87527-187-1.

continued on page 457

J.C. GOLIGHER, CH M, FRCS(EDIN), FRCS

1. Current Use of Sphincter-Saving Excision in the Radical Treatment of Rectal Cancer

The author examines the recent increased use of sphincter-saving forms of excision to treat carcinomas of the middle third and upper part of the lower third of the rectum. This trend has been due chiefly to technical innovations — especially the introduction of the circular stapler, which has extended the downward reach of low anterior resection — and the willingness to accept a distal margin of clearance in resections of 2.0 to 2.5 cm instead of 4 to 5 cm.

Published data show that these innovations are associated with a low operative mortality and that satisfactory anorectal function can be retained. Insufficient length of follow-up, however, has made it impossible so far to calculate valid long-term survival rates and the high incidence of local recurrence in some reports has been disturbing.

L'auteur examine l'augmentation récente du recours à des formes d'excision visant à sauvegarder le sphincter dans le traitement des cancers du tiers moyen et de la partie supérieure du tiers inférieur du rectum. Cette tendance est due principalement à des innovations techniques — tout spécialement à l'avènement de la brocheuse circulaire et étend la portée vers le bas de la résection antérieure basse — et l'acceptation pour la résection d'une marge distale de 2.0 à 2.5 cm plutôt que 4 à 5 cm.

Les publications révèlent que ces innovations sont reliées à une faible mortalité peropératoire et qu'elles permettent de conserver une fonction anorectale adéquate. Le peu de recul du suivi fait toutefois qu'il est impossible de calculer un taux de survie à long terme valable, et la fréquence élevée des récidives locales signalée dans certaines publications est inquiétante.

In a patient with carcinoma of the rectum, it is a very pleasant bonus to be able to excise or destroy the tumour in such a way that a permanent colostomy is not necessary — provided that this does not increase the operative mortality, lessen the prospects of ultimate cure or leave anorectal function so impaired as to represent little better than a perineal colostomy.

For virtually all carcinomas of the upper third of the rectum, this ideal can be readily attained by conventional anterior resection.[1,2] It is when we apply sphincter-saving resection to cancers of the middle and lower parts of the rectum that controversy arises. At one time most surgeons were reluctant to use this operation for such lesions for various reasons (Table I). Over the past 6 or 8 years, there has been a revival of interest in more conservative surgery for malignant disease of the middle and lower thirds of the rectum. This has been due mainly to technical advances.

Before discussing these innovations, I want to emphasize that what makes it possible even to contemplate sphincter-saving resection, certainly for cancers of the middle and lower segments of the rectum, is the fact that when the lateral ligaments are divided at operation and the rectum is mobilized down to the anorectal ring, the anteroposterior and lateral curvatures of the rectum are abolished and the bowel straightens out and lengthens (Fig. 1). Consequently, a tumour seen preoperatively at sigmoidoscopy to be 5 to 6 cm from the anal verge moves proximally to 7 to 8 cm so that it can be resected together with a distal margin of clearance of 2.0 to 2.5 cm — now considered adequate by most,[2-5] but not all,[6] surgeons — and yet leave the anal canal and sphincters intact, often with a small fringe of rectal ampulla. The

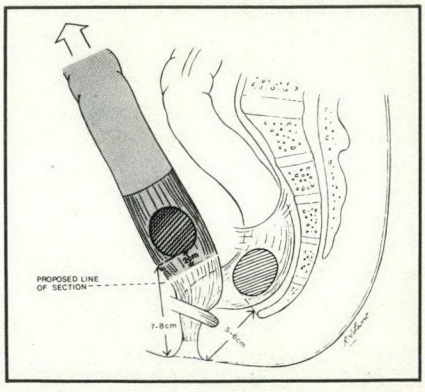


FIG. 1—When lateral ligaments are divided and bowel is mobilized down to anorectal ring, rectum straightens out and lengthens, so that tumour 5 to 6 cm from anal verge on preoperative sigmoidoscopy rises to 7 or 8 cm, allowing resection to be performed with distal margin of clearance of 2 to 3 cm, yet leaving intact not only anal canal and sphincters but also small fringe of rectal ampulla (after Goligher[2]).

Table I—Choice of Radical Operation in 100 Consecutive Unselected Patients With Rectal Carcinoma

Site of tumour	Operation	No. of patients
Upper and middle thirds	Anterior resection with hand suture	55
Difficult growths of middle third and some of lower third	Extended low anterior resection with stapler Abdominoanal or abdominosacral resection Hartmann's procedure or abdominoperineal excision with colostomy	20
Remaining growths of lower third or anal canal	Abdominoperineal excision with colostomy	25

In addition 2 or 3 very early tumours in the lower third might be deemed suitable for local excision or destruction instead of abdominoperineal excision, according to the philosophy of the surgeon.

From Nuffield Hospital, Leeds, UK

Presented as part of a symposium on the controversial aspects of colonic and rectal cancer at the 53rd annual meeting of the Royal College of Physicians and Surgeons of Canada, by the Royal College in cooperation with the Canadian Association of General Surgeons, Montreal, PQ, Sept. 13, 1984

Accepted for publication Mar. 25, 1985

Reprint requests to: Prof. J.C. Goligher, Nuffield Hospital, Outwood Lane, Horsforth, Leeds LS18 4HP, UK

problem then is whether and how colorectal continuity can be restored.

Much depends on the site of the growth, on the sex and physique of the patient (low resections are much easier in women than men and in thin than obese subjects) and on the technical methods that the surgeon can deploy. If standard anterior resection is the only sphincter-saving method he can offer, some of his patients (mainly men with tumours of the lower middle third of rectum), though eligible on pathological grounds for a sphincter-saving resection, will be denied that opportunity and instead be treated by abdominoperineal excision and creation of a permanent colostomy.

Alternative Methods of Sphincter-Saving Excision (or Treatment)

Abdominoanal (Pull-Through) Resection

Originally, this technique achieved union between the resulting colonic stump and the anorectal remnant simply by drawing the colon through the latter, to protrude for 7 to 10 cm beyond the anus. After 2 or 3 weeks the excess colon was amputated. Later versions have been more elaborate, as in Parks's method,[7] which provides for a sutured endocavitary coloanal anastomosis. Abdominoanal resection was once popular in certain clinics in the United States but its popularity has declined.[2]

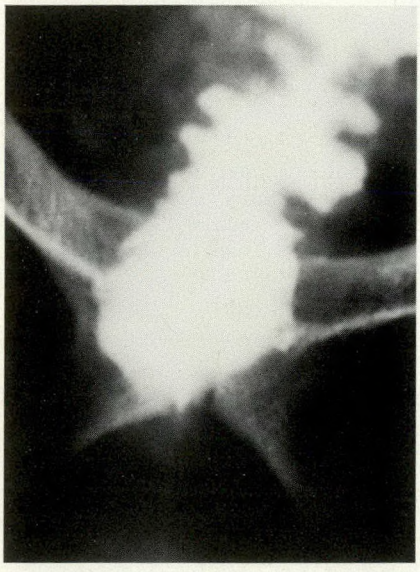


Fig. 2a

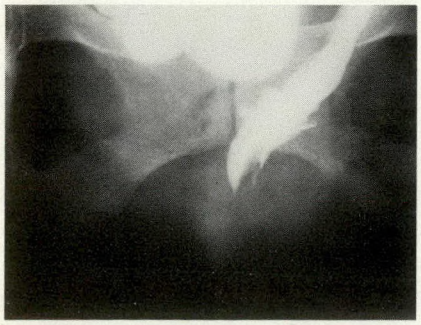


Fig. 2b

FIG. 2—Roentgenograms after small cautiously administered Gastrografin enemas, 12 days following low anterior resection in very obese men with carcinomas of lower middle third of rectum. Sites of anastomoses are indicated by metal staples. There is no leakage (after Goligher[2]).

Abdominosacral (or Abdominoposterior Trans-sphincteric) Resection

In abdominosacral resection,[2] after a thorough mobilization of the left colon and rectum down to the anorectal junction during an initial abdominal phase, resection and anastomosis are performed through a sacral incision. Currently, the leading exponent of this technique is Arthur Localio of New York,[8] who has had most impressive results with it. In Britain, Mason[9] has been an equally staunch advocate of a modification of the operation in which the sacrococcygeal approach is replaced by a posterior trans-sphincteric one. Despite the enthusiastic reports of these two advocates, neither version of the procedure has attracted much support.

Extended Low Anterior Resection Using the New Circular Staplers

From personal experience[2] with abdominoanal and abdominosacral resection, I know that both are eminently practicable methods, but unquestionably far simpler to perform and much more popular is the extended low anterior resection using the new circular staplers.[2,10] The great attraction of the circular stapler is not that it constructs anastomoses more quickly or securely than hand suturing but that it makes possible from above some anastomoses that would be impossible without it, especially in heavily built men with tumours of the low middle third[2,10,11] (Fig. 2). With the aid of the stapler, about 15% of patients requiring operation for cancer of the rectum can now have an anterior resection.

Table II—Characteristics of a Sessile Rectal Cancer, Suggesting That it May Be an Early or Entirely Submucosal Lesion

Not more than 3 cm in diameter
Protuberant or not deeply ulcerating
Mobile on underlying muscle coat
No palpable pararectal lymph nodes
At least moderately well differentiated on biopsy

Table III—Satisfactory Findings on Histopathological Examination of Disc-Removal Specimen of Rectal Carcinoma

Confirms that in no part of the tumour on multiple sections is the lesion of less than average differentiation
Shows that the tumour is confined to the submucosa or at most invades only the most superficial part of the muscle coat
Reveals a margin of 0.5–1.0 cm of normal bowel wall at all parts of the periphery of the lesion

Local Disc Excision of the Primary Tumour Through a Perianal or Posterior Trans-sphincteric Approach,[2] or Its Destruction by Diathermy Fulguration[12,13] or Endocavitary Contact Irradiation[14]

The rational use of these measures depends on two conditions. The first is that on pathological examination of excised specimens, some rectal cancers are found to be confined strictly to the rectal wall (Dukes' class A); 15% of tumours are in this category with 3% actually lying entirely within the submucosa.[2] The second is that it is possible to recognize with a high degree of accuracy (although not 100%) on clinical examination which carcinomas are in this category. To lessen the risk of error, most surgeons try to select for purely local treatment not just Dukes' class A cases but also those with submucosal lesions, using the clinical criteria listed in Table II. But I stress that, even if the surgeon is correct in determining that direct spread of a tumour is confined to the submucosa, there is still an 11% risk of nodal metastases being present,[15] for which purely local therapy is quite ineffective. To compensate for this weakness, local treatment carries virtually no operative mortality, even in poor-risk patients, as against an immediate mortality for rectal excision in such unfit subjects of 8% to 10%. In other words, local excision or destruction is best reserved for patients with early favourable lesions, who are also unfavourable candidates for formal rectal excision.

Relative Use of Sphincter-Saving Techniques for Cancers of the Middle or Lower Thirds of Rectum

In Table III, I have attempted to put the indications for the recently favoured sphincter-saving procedures for carcinomas of the middle and lower part of the rectum in proper perspective in the overall management of rectal cancer. As many as 75% of patients with rectal cancer may now be treated by a sphincter-saving type of resection—in about 55%, a conventional anterior resection with hand suture may be used, while in 20% other forms of sphincter-saving resection are required for lesions in the middle or

Table IV—Comparison of 5-Year Survival Rates After Abdominoperineal Excision and Abdominoanal Resection for Carcinomas of the Middle Third of the Rectum

Type of operation	Level above anal verge, cm	No. patients treated	No. (%) alive ≥ 5 yr
Abdominoperineal excision	6–10	182	93 (51)
Abdominoanal resection	5–10 (in 81% of cases)	131	69 (53)

Hospital deaths and palliative cases were excluded. Adapted from Waugh and Turner.[21]

Table V—Incidence (%) of Local Recurrence After Abdominoperineal Excision for Rectal Carcinoma According to Various Authors

	Series		
Site of lesion	Stearns and Binkley[23] (N = 369)	Gilbertsen[24] (N = 117)	Morson and associates[25] (N = 1596)
Upper third	14	?	5
Middle third	20	?	8
Lower third	30	?	14
All sites	22	24	10

Table VI—Incidence of Local Recurrence After Anterior Resection With Hand Suture for Rectal Cancers in the Upper and Middle Thirds of the Rectum

	Series			
	Deddish and Stearns, 1961[26]		Cullen and Mayo, 1963[27]	
Site of lesion in rectum	No. treated	No. (%) recurrences	No. treated	No. (%) recurrences
Upper third	99	5 (5)	158	20 (13)
Middle third	51	6 (12)	81	19 (23)
All sites	150	11 (7.3)	239	39 (16)

Of 50 local recurrences, 32 were anastomotic, 18 pelvic.

lower thirds. Purely local treatment is reserved for as few as 2% to 3% of patients with growths in the lower third.

Results of the Newest Sphincter-Saving Forms of Resection for Cancers of the Middle and Lower Thirds of the Rectum

Operative Mortality and Morbidity

There are many published reports[2,8,11,16-20] showing that the operative mortality after the three forms of resection has been roughly similar, about 3% to 4%. The average incidence of anastomotic leakage after low stapled anastomoses has been about 14%[2,10,11,16,17] and a similar figure is quoted in the literature for abdominoanal and abdominosacral resections,[8,18,19] although my modest experience[2] of the latter two procedures has been less favourable, with more complications from dehiscence, pelvic sepsis and hematoma formation than after low anterior resection with the stapler.

Functional Results

Recent experience with very low resections has shown conclusively that after colorectal anastomoses as low as 4 and 5 cm from the anal verge or even after coloanal anastomoses, anal control can eventually often be normal.[2,17] The relevant word is "eventually", because function is at first usually greatly disturbed, with frequency and urgency of defecation; often the patient has 8 to 12 bowel

Table VII—Incidence of Local Recurrence After Sphincter-Saving Resection for Carcinomas Mainly of the Middle Third of the Rectum in Recent Years

Series	Operative method	Period of follow-up, yr	No. patients treated	No. (%) of recurrences
Goligher, 1982[1]	Abdominosacral	2–5	18	2 (11)
Localio and associates, 1983[8]	Abdominosacral	5+	89	13 (15)
Parks and Percy, 1982[19]	Abdominoanal	1–5	73	6 (8)
Keighley and Matheson, 1980[20]	Abdominoanal	1–3	7	3 (43)
Hurst and associates, 1982[28]	Anterior resection with stapler	0.5–2	34	11 (32)
Luke and associates, 1983[29]	Anterior resection with stapler	2.5–5	44	10 (23)
Anderberg and associates, 1983[30]	Anterior resection with stapler	?	39	9 (23)
Lasson and associates, 1984[31]	Anterior resection with stapler	0.5–3	40	8 (20)
Reid and associates, 1984[32]	Anterior resection with stapler	2–6	29	8 (28)
Heald, 1984 (personal communication)	Anterior resection with stapler	0.5–4	110	3 (3)
Oates, 1984 (personal communication)	Anterior resection with stapler	0.5–4	60	4 (7)
Goligher, 1984 (unpublished data)	Anterior resection with stapler	2–7	120	11 (9)

Table VIII—Outcome of Local Excision for Small Early Frank Sessile Rectal Cancers According to Various Authors

Series	Method	No. of patients	Early reoperation for suspected incomplete removal, %	Length of follow-up, yr	No. (%) of recurrences	No. (%) of cancer deaths
Hawley and Ritchie, 1980[33]	Mostly peranal	42	14	1–30	7 (20)*	2 (6)*
Hermanek and associates, 1980[34]	Peranal	48	20	Mean 3	5 (13)*	1 (3)*
Mason, 1983 (personal communication)	Posterior trans-sphincteric	36	?	5–15	5 (14)	2 (6)

*Patients having early rectal excision were excluded from the calculation of local recurrence.

movements in 24 hours that cannot always be completely controlled. However, over the next 3 to 6 months, there is usually gradual improvement, the frequency of bowel movements is reduced to four or fewer daily and full continence is regained.

Ultimate Cure

Five-year survival.—Unfortunately, not enough patients with growths of the middle and lower thirds of the rectum have yet been treated by the newer sphincter-saving resections or followed up for long enough to enable worthwhile 5-year survival rates to be calculated; in another 2 or 3 years sufficient data should emerge. Meanwhile, some older statistics from the Mayo Clinic warrant attention. There, in the 1940s and 1950s, John Waugh did many abdominoanal resections for tumours of the middle third of the rectum. He used the Bacon–Babcock technique[2] which gave poor functional results and has since been abandoned; nevertheless, insofar as excision was concerned, this technique did not differ significantly from the more recent techniques of sphincter-saving resection now in favour. Admittedly, Waugh and Turner's[21] comparison of abdominoanal resection with abdominoperineal excision (Table IV) was not properly controlled, but it did suggest that the two operations were almost equally effective in the cure of middle-third tumours. A similar study recently from St. Mark's Hospital, London,[22] reached the same conclusion.

Incidence or absence of local recurrence.—As is well known, local recurrence is a not-infrequent sequel to abdominoperineal excision for rectal cancer, being commoner the more advanced the growth and the lower it is located in the rectum (Table V[23-25]). It might have been expected that recurrence would be at least as frequent after sphincter-saving resections. That this is not so is presumably owing to a degree of selection of patients for these operations with rejection of those who have really low growths or particularly extensive spread. But the incidence of local recurrence after sphincter-saving resection also increases the more advanced the lesions are and the deeper they lie in the rectum (Table VI[26,27]). Some of the recurrences are closely related to the anastomotic site, others are more diffusely situated in the pelvis. The data in Table VI relate to patients treated in the late 1950s. As the tendency in the recent revival of sphincter-saving resections has been to take on even lower growths, a still greater incidence of local recurrence would be a reasonable consequence. Some recent reports (Table VII[1,8,19,20,28-32]) have in fact recorded recurrence rates of the order of 30% after extended low anterior resection using the circular stapler, but fortunately several other workers, who have used the stapler a great deal for this purpose, have not so far encountered any large number of local recurrences. Obviously, these recurrence rates need to be monitored closely. It is, however, hard to understand how the method of joining two segments of bowel together should affect the incidence of recurrence.

Results of Local Excision of the Primary Tumour

Some of the more important published reports on the results of local removal are shown in Table VIII. It should be emphasized that the lesions dealt with in all these cases were small, frank, sessile carcinomas and not just apparently benign polyps removed by snaring and found on histologic examination to be malignant. The series of Hawley and Ritchie[33] and Hermanek and colleagues[34] represented the collective efforts of St. Mark's Hospital, London and the University Surgical Clinic, Erlangen, respectively, while the report from Mason (personal communication, 1983) refers to an entirely personal series. In the first two series note the resort to early reoperation in 14% and 20% of the cases, when the pathologist found that the growth in the excised disc specimen was more deeply invasive or more active than had been thought on the preoperative clinical examination and biopsy. A 10% to 20% recurrence rate may not seem excessive, but it must be remembered that nearly all the cases in these series had Dukes' A or super A (entirely within the submucosa) lesions, which makes it somewhat less creditable.

Conclusions

Evidence has accumulated to show that, in the recent wave of sphincter-saving excisions for cancers of the middle and lower parts of the rectum during the past decade, most of the objections hitherto levelled at this type of operation for such tumours seem to have been overcome. However, there is still uncertainty as to the precise incidence and mechanism of local recurrence after their use for very low lesions and continued close scrutiny of this issue is of paramount importance.

References

1. GOLIGHER JC: Current trends in the use of sphincter-saving excision in the treatment of carcinoma of the rectum. *Cancer* 1982; 50(11 suppl): 2627–30
2. Idem: *Surgery of the Anus, Rectum and Colon*, 5th ed, Baillière Tindall, London, 1984
3. PENFOLD JCB: A comparison of restorative resection of carcinoma of the middle third of the rectum with abdominoperineal excision. *Aust NZ J Surg* 1974; 44: 354–6
4. MANSON PN, CORMAN ML, COLLER JA, VEIDENHEIMER MC: Anastomotic recurrence after anterior resection for carcinoma: Lahey Clinic experience. *Dis Colon Rectum* 1976; 19: 219–24
5. POLLETT WG, NICHOLLS RJ: The relationship between the extent of distal clearance and survival and local recurrence rates after curative anterior resection for carcinoma of the rectum. *Ann Surg* 1983; 198: 159–63
6. HERMANEK P, GALL FP: [Safe aboral distance in sphincter-preserving resection of the rectum.] *Chirurg* 1981; 52: 25–9
7. PARKS AG: Transanal technique in low rectal anastomosis. *Proc R Soc Med* 1972; 65: 975–6
8. LOCALIO SA, ENG K, COPPA GF: Abdominosacral resection for midrectal cancer. A fifteen-year experience. *Ann Surg* 1983; 198: 320–4
9. MASON AY: Selective surgery for carcinoma of the rectum. *Aust NZ J Surg* 1976; 46: 322–9
10. GOLIGHER JC, LEE PW, MACFIE J, SIMPKINS KC, LINTOTT DJ: Experience with the Russian model 249 suture gun for anastomosis of the rectum. *Surg Gynecol Obstet* 1979; 148: 516–24
11. BEART RW JR, KELLY KA: Randomized prospective evaluation of the EEA stapler for colorectal anastomoses. *Am J Surg* 1981; 141: 143–7
12. MADDEN JL, KANDALAFT S: Electrocoagulation in the treatment of cancer of the rectum. A continuing study. *Ann Surg* 1971; 174: 530–40
13. CRILE G JR, TURNBULL RB JR: The role of electrocoagulation in the treatment of carcinoma of the rectum. *Surg Gynecol Obstet* 1972; 135: 391–6
14. PAPILLON J: *Rectal and Anal Cancers: Conservative Treatment by Irradiation, an Alternative to Radical Surgery*, Springer-Verlag, New York, 1982
15. MORSON BC: Factors influencing the prognosis of early cancer of the rectum. *Proc R Soc Med* 1966; 59: 607–8
16. HEALD RJ, LEICESTER RJ: The low stapled anastomosis. *Br J Surg* 1981; 68: 333–7
17. THIEDE A, JOSTARNDT L, TROIDL H, POSER HL, BERTZ U, HAMELMANN H: [Value of circular mechanical colon and rectum anastomosis. Prospective study of 91 patients.] *Chirurg* 1981; 52: 30–5
18. DONALDSON GA, RODKEY GV, BEHRINGER GE: Resection of the rectum with anal preservation. *Surg Gynecol Obstet* 1966; 123: 571–80
19. PARKS AG, PERCY JP: Resection and sutured colo-anal anastomosis for rectal carcinoma. *Br J Surg* 1982; 69: 301–4
20. KEIGHLEY MR, MATHESON D: Functional results of rectal excision and endo-anal anastomosis. *Br J Surg* 1980; 67: 757–61
21. WAUGH JM, TURNER JC JR: A study of 268 patients with carcinoma of the mid-rectum treated by abdominoperineal resection with sphincter preservation. *Surg Gynecol Obstet* 1958; 107: 777–83
22. NICHOLLS RJ, RITCHIE JK, WADSWORTH J, PARKS AG: Total excision or restorative resection for carcinoma of the middle third of the rectum. *Br J Surg* 1979; 66: 625–7
23. STEARNS MW JR, BINKLEY GE: Influence of location on prognosis in operable rectal cancer. *Surg Gynecol Obstet* 1953; 96: 368–70
24. GILBERTSEN VA: Adenocarcinoma of the rectum: incidence and locations of recurrent tumor following present-day operations performed for cure. *Ann Surg* 1960; 151: 340–8
25. MORSON BC, VAUGHAN EG, BUSSEY HJ: Pelvic recurrence after excision of rectum for carcinoma. *Br Med J* 1963; 2: 13–8
26. DEDDISH MR, STEARNS MW JR: Anterior resection for carcinoma of the rectum and rectosigmoid area. *Ann Surg* 1961; 154: 961–6
27. CULLEN PK JR, MAYO CW: A further evaluation of the one-stage low-anterior resection. *Dis Colon Rectum* 1963; 6: 415–21
28. HURST PA, PROUT WG, KELLY JM, BANNISTER JJ, WALKER RT: Local recurrence after low anterior resection using the staple gun. *Br J Surg* 1982; 69: 275–6
29. LUKE M, KIRKEGAARD P, LENDORF A, CHRISTIANSEN J: Pelvic recurrence rate after abdominoperineal resection and low anterior resection for rectal cancer before and after introduction of the stapling technique. *World J Surg* 1983; 7: 616–9
30. ANDERBERG B, ENBLAD P, SJÖDAHL R, WETTERFORS J: Recurrent rectal carcinoma after anterior resection and rectal stapling. *Br J Surg* 1984; 71: 98–100
31. LASSON AL, EKELUND GR, LINDSTRÖM CG: Recurrence risk after stapled anastomosis for rectal carcinoma. *Acta Chir Scand* 1984; 150: 85–9
32. REID JD, ROBINS RE, ATKINSON KG: Pelvic recurrence after anterior resection and EEA stapling anastomosis for potentially curable carcinoma of the rectum. *Am J Surg* 1984; 147: 629–32
33. HAWLEY PR, RITCHIE JM: Indications, technique and results of transanal tumour excision in cases of lower rectal carcinoma. In REIFFERSCHEID M, LANGER S (eds): *Der Mastdarmkrebs: schliessmuskelerhaltende Therapieverfahren und ihre Idikationsgrenzen, Symposion Aachen 1979*, Thieme, Stuttgart, 1980
34. HERMANEK P, ALTONDORF A, GUNSELMANN W: Pathomorphologische Aspekte zu kontinenzerhaltenden Therapierfahren bei Mastdarmkrebs. In ibid

NORMAN WOLMARK, MD, CM, FRCSC, FACS

2. Adjuvant Chemotherapy in Colorectal Cancer

The current status of adjuvant therapy for colorectal cancer is reviewed using examples from selected, recently completed, randomized, prospective, clinical trials. Although adjuvant systemic therapy is of limited therapeutic efficacy in cancer of the colon, there have been examples of beneficial effects in specific patient subsets. The rationale and current status of adjuvant portal vein hepatic perfusion suggest that it represents a potentially promising approach that must be evaluated in a large prospective randomized study. Finally, the value of adjuvant radiotherapy and chemotherapy for carcinoma of the rectum is assessed. Although one study has demonstrated increased disease-free survival for patients receiving a combination of chemotherapy and radiotherapy, the small numbers in the study preclude any definitive conclusions. The current National Surgical Adjuvant Breast Project, rectal protocol R-01, the largest rectal cancer study with a concomitant "untreated" control, is reviewed and discussed.

La situation actuelle des traitements d'appoint du cancer colorectal est étudiée à la lumière d'exemples tirés d'essais cliniques prospectifs randomisés qui ont été terminés récemment. Bien que le traitement systémique d'appoint soit d'une efficacité thérapeutique limitée dans le cancer du côlon, on a constaté des exemples d'effets bénéfiques parmi des sous-groupes spécifiques de malades. Les raisons et la situation présente de la perfusion veineuse porte utilisée en traitement d'appoint indiquent que cette approche représente possiblement une méthode prometteuse valant la peine d'être évaluée dans un vaste essai randomisé. On examine finalement l'intérêt de la radiothérapie et de la chimiothérapie d'appoint pour le cancer du rectum. Bien qu'une étude ait montré une prolongation du temps de survie exempt de maladie chez des patients qui ont reçu une association de chimiothérapie et de radiothérapie, le petit nombre de sujets compris dans l'étude ne permet aucune conclusion définitive. Le protocole R-01 du National Surgical Adjuvant Breast Project pour le cancer du rectum, la plus vaste étude du cancer du rectum ayant un groupe témoin "non traité," est décrit et commenté.

From the Department of Surgery, School of Medicine, University of Pittsburgh, Pittsburgh, Pa.

Presented as part of a symposium on the controversial aspects of colonic and rectal cancer at the 53rd annual meeting of the Royal College of Physicians and Surgeons of Canada, by the Royal College in cooperation with the Canadian Association of General Surgeons, Montreal, PQ, Sept. 13, 1984

Accepted for publication Mar. 25, 1985

Reprint requests to: Dr. N. Wolmark, Department of Surgery, School of Medicine, University of Pittsburgh, 3459 Fifth Avenue, Pittsburgh, PA 15213, USA

The emphasis placed on studies in adjuvant therapy depends on the natural history of the disease under consideration. Survival data for colorectal cancer indicate that a complacent attitude towards surgery alone is unjustified. The belief that microdissemination is present at the time of surgery has led to current efforts in assessing systemic therapy as an adjunct to operative resection. The greatest drawback to the use of adjuvant chemotherapy for colorectal cancer is the failure to identify agents that are particularly effective in patients with advanced disease. Colorectal cancer is particularly resistant to chemotherapeutic manipulations. The early promise of such combinations as methyl-cyclohexyl-chloroethyl-nitrosourea (MeCCNU), 5-fluorouracil (5-FU) and vincristine (VCR) for advanced colorectal cancer has been dampened by the subsequent demonstration that these combinations have no advantage over 5-FU alone.[1,2] The previous generation of randomized prospective trials in adjuvant chemotherapy for colonic cancer has been based mostly on the nitrosourea-fluorinated pyrimidine baseline, but the anticipated synergism between the two agents was found to be specious in the setting employed. Even though the premise for those adjuvant trials was erroneous, it was essential to review the data objectively.

Adjuvant Clinical Trials of Multiple Agents

Selected representative examples of adjuvant clinical trials will provide a reasonable overview of the whole. It is regrettable that some studies did not include a concurrent "untreated" control, thus eliminating the ability adequately to analyse the data and to assess the natural history of the disease in a controlled setting. The following three studies illustrate the current efforts being made to treat colonic cancer.

Veterans' Administration Surgical Oncology Group (VASOG), Protocol 27 A[3]

This trial (Table I), which studied 653 patients between 1973 and 1979, deserves special mention because it provides the longest follow-up of any study of combination chemotherapy, nearly all patients having been studied for 5 years. Patients randomized to receive chemotherapy were given 5-FU intravenously, 9 mg/kg daily for 5 successive days, along with a single oral dose of MeCCNU, 120 mg/m^2, on day 1. Cycles were repeated every 7 weeks for 12 months. Of the 653 patients, 645 were available for evaluation. When the data were analysed in all patients without regard for nodal status, no significant differences in survival were found.[3] However, when the presence or absence of regional nodal metastases were considered, patients with positive nodes demonstrated prolonged survival that was attributable to the chemotherapy. This statistically significant difference ($p = 0.004$) in survival was derived exclusively from patients with one to four nodes positive for malignant disease. This study represents one of the few instances in which combination chemotherapy appears to have altered the natural his-

tory of colonic cancer, although the alteration was limited to a specific subset of patients.

Gastrointestinal Study Group (GITSG), Protocol 6175[4]

This study was started in 1975 and completed in 1979 after 621 patients had been randomized (Table I). It was a four-arm study evaluating combination chemotherapy (MeCCNU and 5-FU) and immunotherapy (methanol-extractable residue of bacille Calmette Guérin [MER-BCG]). It included only patients with carcinoma of the colon (more than 12 cm from the anal verge) with full-thickness penetration and positive nodes (Dukes' classes B and C). Patients were stratified according to the number of positive nodes; a C_1 lesion was defined as a tumour associated with fewer than five histologically positive nodes and a C_2 lesion as being associated with five or more positive nodes. It is interesting that, unencumbered by the results from the VASOG study, the GITSG trial 6175 has been cited as indicative of the failure of adjuvant chemotherapy to prolong disease-free survival.[4] The data indicated that after more than 5 years of follow-up, no significant differences were apparent for either recurrence or survival. The prolonged time to recurrence previously reported for combined chemoimmunotherapy was no longer significant in the most recent analysis. A critically important aspect of this study was the demonstration that 29% of the patients receiving chemotherapy suffered grade 2 or worse hematologic toxicity and seven patients were noted to have acute non-lymphocytic leukemia, presumably drug-related. This information stresses the need to assess any putative benefits in the light of potential risk.

National Surgical Adjuvant Breast Project (NSABP), Protocol C-01

This protocol (Fig. 1, Table I) was initiated in 1977 and was terminated in 1983 after 1166 patients with Dukes' class B or C tumours had been entered; this was the largest number accumulated in the current series of clinical trials. Patients were randomized into three arms: (a) control, no further treatment after curative resection, (b) chemotherapy and (c) BCG. Eligibility was limited to patients with standard Dukes' class B lesions (Kirklin B_2) and those patients with Dukes' class C tumours. A colonic tumour was defined by the protocol as any lesion that did not require opening of the pelvic peritoneum to identify the distal margin. The chemotherapy differed from the other cooperative groups in that three drugs were used: 5-FU, MeCCNU and vincristine. The results of this study have taken on a greater importance in the light of the apparently conflicting conclusions obtained from the VASOG and GITSG studies. Preliminary results (an average study period of 41 months) indicate that the chemotherapy cohort demonstrates a small but significant ($p = 0.05$) prolongation in disease-free survival independent of the Dukes class.

The differences noted with adjuvant combination chemotherapy are clearly of limited therapeutic application. With the documented risk of acute non-lymphocytic leukemia attributable to MeCCNU, it is inappropriate to use nitrosourea combinations in the adjuvant setting. From a biologic standpoint, however, it may very well be that colonic cancer, like breast cancer, is manifesting a heterogeneous response to adjuvant therapy in that certain subsets may demonstrate a response to adjuvant chemotherapy.

Table I—Adjuvant Trials in Colonic Cancer

Trial (accrual interval)	Treatment regimen after resection of primary tumour	No. of patients
Veterans' Administration Surgical Oncology Group, protocol 27 A (1973–1979)	5-FU + MeCCNU No further therapy	653
Gastrointestinal Study Group, protocol 6175 (1975–1979)	5-FU + MeCCNU MER 5-FU + MeCCNU + MER No further therapy	621
Southwest Oncology Group, protocol 7510* (1975–1978)	5-FU + MeCCNU 5-FU + MeCCNU + oral BCG	626
Eastern Cooperative Oncology Group, protocol EST 2276 (1976–1978)	5-FU 5-FU + MeCCNU	866
National Surgical Adjuvant Breast Project, Protocol C-01 (1977–1983)	5-FU + MeCCNU + VCR BCG No further therapy	1166
North-Central Cancer Treatment Group, protocol 4852 (1978–)	Levamisole Levamisole + 5-FU No further therapy	300

*Untreated control arm added in mid-1977.
5-FU = 5-fluorouracil, MeCCNU = methyl-cyclohexyl-chloroethyl-nitrosourea, MER = methanol-extractable residue of BCG, BCG = bacille Calmette Guérin, VCR = vincristine.

Adjuvant Clinical Trials of Local and Regional Therapy

Before discounting studies in which the therapy is regionally oriented, I must point out that the most intriguing preliminary results have been provided by just such a study. In 1975, Taylor and associates, in Liverpool, initiated an adjuvant trial in which the portal vein was infused with 5-FU following resection of the primary tumour.[5-7] The logic for this was based on the contention that in a substantial proportion of patients with colorectal cancer, metastases will develop in the liver as the first and only site of recurrence. Although the exact incidence of hepatic metastasis is difficult to establish, it has been argued that a therapeutic regimen which could effectively decrease hepatic metastasis would alter the natural history of the disease and result in improved survival. Although most evidence suggests that established hepatic metastases are supplied predominantly by the hepatic artery, the portal vein has been found to play an important role, particularly in supplying smaller tumours. Thus, in the trial undertaken by Taylor's group, patients were randomized after resection to receive portal vein hepatic perfusion through the umbilical vein or no further treatment. 5-fluorouracil was given on 7 successive days (1000 mg/d) starting postoperatively; heparin (5000 units/d) was also given. Between 1975 and 1981, 212 patients entered the study; 97 were evaluated in the control group and 90 in the perfusion group. Hepatic metastases developed in 17 control patients compared with 5 treated patients; however, the incidence of local and regional recurrences appeared unchanged. The patients who seemed to sustain the greatest benefit from therapy were those with Dukes' class B tumours; those with class C lesions derived minimal benefit.

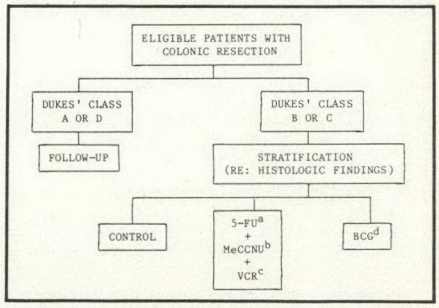


FIG. 1—National Surgical Adjuvant Breast Project, protocol C-01. 5-FU = 5-fluorouracil, MeCCNU = methyl-cyclohexyl-chloroethyl-nitrosourea (semustine), VCR = vincristine. a = 325 mg/m² intravenously, days 1 to 5, 375 mg/m², days 36 to 40. b = 130 mg/m² orally, day 1. c = 1 mg/m² (max 2 mg) intravenously, days 1 and 36. a, b and c every 10 weeks for eight courses. d = scarification every week for 12 weeks, then every 2 weeks, 28 times.

These results were achieved with very little toxicity.

The design and patient randomization in this study have been criticized. The 5-FU dose was constant and was not determined by the patient's surface area. Moreover, the effect of adding heparin to the infusate was not controlled and it is possible that the heparin may have had a tumour-inhibiting effect. The criteria for eligibility were such that some patients with Dukes' class D tumours were entered, making data interpretation more difficult. In spite of these criticisms, the study provided preliminary results that warrant optimism. If nothing else this treatment regimen is certainly worth testing on large numbers of patients in a cooperative group setting.

In an effort to assess the propriety of portal vein hepatic perfusion, the NSABP initiated protocol C-02 in March 1984. Patients with colorectal carcinomas in Dukes' classes A, B and C are randomized to receive portal vein hepatic perfusion with 5-FU, 600 mg/m^2, and 5000 units of heparin on 7 successive days or no further treatment following colonic resection carried out for cure. To date, over 300 patients have entered the study. This trial represents a definitive test of regional hepatic perfusion in the adjuvant setting and will be instrumental in assessing a potentially innovative adjuvant therapy.

Adjuvant Trials in Rectal Cancer

Two studies have satisfactorily addressed the propriety of adjuvant therapy in rectal cancer (Table II).

Gastrointestinal Study Group, Protocol 7175

In this study a beneficial effect has been claimed for adjuvant therapy. Because of the important influence that these findings may have and have already imparted, it is essential to review the data carefully and in detail. This study was started in 1975 and terminated in September 1980 after 227 patients had been randomized; 202 were available for evaluation. The study defined a rectal cancer as being within 12 cm of the anal verge. Patients were randomized into four arms after resection of the primary tumour (Table II): (a) control — no further treatment, (b) chemotherapy consisting of MeCCNU and 5-FU, (c) radiotherapy consisting of 4000 to 4800 rad delivered in 4½ to 5½ weeks and (d) a combination of b and c. The initial projected sample-size estimates were for 520 patients to be evaluated in order to detect a 50% increase in median survival time for 2 to 3 years. In February 1980, it was noted that one of the randomized arms was inferior to the other three; as a result, that arm was unblinded. The inferior group proved to be the control group and as a result randomization into this arm was discontinued and the protocol was terminated shortly thereafter. Consequently, the number of patients in each group is small: of the 202 patients, 58 were untreated, 48 received chemotherapy, 50 radiotherapy and 46 combination therapy. Results of this study after a median follow-up of 80 months have recently been disclosed.[8] They indicated that 55% of the control group had recurrent tumour compared with 46% for chemotherapy alone, 48% for radiotherapy and 33% for the combined regimen.[8] A significant ($p = 0.009$) pair-wise difference in disease-free survival was noted when the control group was compared with the combined therapy group. The strongest therapeutic benefits were evident in patients with C_1 lesions (fewer than five affected nodes) in whom significant differences were evident among the treatment arms. Analysis of site of recurrence information again suggested an advantage in favour of the combined treatment arm. There was no significant difference in survival for any of the treatment arms over operation alone. Two treatment-associated deaths in the combined treatment arm were attributed to radiation enteritis. The long-term incidence of radiation enterocolitis has yet to be determined. The toxicity of this regimen has been addressed by a subsequent rectal protocol initiated by the GITSG in 1980 (GITSG 7180). This study represents a retreat from GITSG 7175 in that the identical combined radiotherapy-chemotherapy arm is compared to one in which the MeCCNU has been eliminated in favour of the 5-FU only.

The data from the GITSG protocol 7175 must be regarded as a major conceptual advance. They must be viewed as an important initial indicator of the value of adjuvant therapy in patients with Dukes' class B and C rectal cancers. However, with only 46 patients available for analysis in the group demonstrating the greatest benefit and with the magnitude of major toxicity encountered, it is premature and inappropriate to extrapolate these results to the treatment of patients outside the context of clinical trials. The GITSG results must await confirmation from trials now in progress in which adequate sample sizes are available.

National Surgical Adjuvant Breast Project, Protocol R-01

The final study that merits review is that of the NSABP. This study was initiated in 1977 and to date over 500 patients with Dukes' class B or C rectal lesions have been randomized after resection into three treatment arms: control with no further treatment, chemotherapy consisting of 5-FU, MeCCNU and VCR and postoperative radiotherapy with a central midline dose of 3200 to 4000 rad delivered in 18 to 22 fractions (Fig. 2). A rectal tumour is defined by this study as one that requires the intraoperative opening of the pelvic peritoneum in order to define the distal margin of the lesion. This protocol, which has presently accrued the largest number of patients, is the only study currently in a position to compare the results of adjuvant chemotherapy and radiotherapy to a concomitant untreated control. Consequently, the results of this study are of pivotal importance. As of the middle of 1984 with 41 months' mean time in the study, there appear to be differences in men younger than 65 years. Since the groups remain blinded with respect to identity, conclusions on the efficacy of the treatment modalities cannot be formulated. Until the results of this study become available, adjuvant therapy

Table II—Adjuvant Trials in Rectal Cancer

Trial (accrual interval)	Treatment regimen after resection of primary tumour	No. of patients
Gastrointestinal Study Group, protocol 7175 (1975–1980)	5-FU + MeCCNU Postoperative radiotherapy 5-FU + MeCCNU + radiotherapy No further therapy	194
Eastern Cooperative Oncology Group, protocol EST 4226 (1976–)	5-FU + MeCCNU Postoperative radiotherapy 5-FU + MeCCNU + radiotherapy	279
National Surgical Adjuvant Breast Project, protocol R-01 (1977–)	5-FU + MeCCNU + VCR Postoperative radiotherapy No further therapy	500

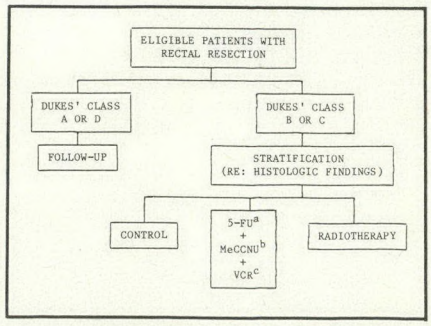


FIG. 2—National Surgical Adjuvant Breast Project, protocol R-01. a, b and c as in Fig. 1.

either in the form of chemotherapy, radiotherapy or the combination of the two must be regarded as experimental in carcinoma of the rectum.

References

1. MOERTEL CG, SCHUTT AJ, HAHN RG, REITEMEIER RJ: Therapy of advanced colorectal cancer with a combination of 5-fluorouracil, methyl-1,3-cis(2-chloroethyl)-1-nitrosourea, and vincristine. *J Natl Cancer Inst* 1975; 54: 69–71
2. FALKSON G, FALKSON HC: Fluorouracil, methyl-CCNU and vincristine in cancer of the colon. *Cancer* 1976; 38: 1468–70
3. HIGGINS GA, AMADEO JH, MCELHINNEY J, MCCAUGHAN JJ, KEEHN R: Efficacy of prolonged intermittent therapy with combined 5 FU and MeCCNU following resection for carcinoma of the large bowel. *Cancer* 1984; 53: 1–8
4. Gastrointestinal Tumor Study Group: Adjuvant therapy of colon cancer — results of a prospectively randomized trial. *N Engl J Med* 1984; 310: 737–43
5. TAYLOR I: Studies on the treatment and prevention of colorectal liver metastases. *Ann R Coll Surg Engl* 1981; 63: 270–6
6. TAYLOR I, BROOMAN P, ROWLING JT: Adjuvant liver perfusion in colorectal cancer: initial results of a clinical trial. *Br Med J* 1977; 2: 1320–2
7. TAYLOR I, ROWLING J, WEST C: Adjuvant cytotoxic liver perfusion for colorectal cancer. *Br J Surg* 1979; 66: 833–7
8. Gastrointestinal Tumor Study Group: Prolongation of the disease-free interval in surgically treated rectal carcinoma. *N Engl J Med* 1985; 312: 1465–72

B. LANGER, MD, FRCSC, FACS

3. Colorectal Cancer: Managing Distant Metastases

The best opportunity for cure in colorectal cancer is early diagnosis and complete excision of the primary disease. Currently, metastatic disease develops in about 50% of patients, most often in the liver. Resection of solitary liver metastases is warranted, and a 5-year survival of at least 25% can be expected. Patients with limited unilobar multiple metastases may also benefit from resection. Extensive metastatic disease to the liver may respond to single or combination chemotherapy. Response rates are highest with hepatic artery infusion chemotherapy, but improvement in survival has not clearly been shown. Solitary or limited lung metastases, when unassociated with other metastatic disease, should also be resected. Multiorgan involvement may respond to systemic chemotherapy but results are generally poor. Palliation is an important objective of therapy, involving not only anticancer treatment (surgery, chemotherapy, radiotherapy) but also general supportive care.

La meilleure chance de guérison du cancer colorectal repose sur un diagnostic précoce et l'excision complète de la tumeur primitive. Dans l'état actuel des choses des métastases apparaissent chez environ 50% des patients, la plupart du temps au foie. La résection des métastases hépatiques solitaires est indiquée et on peut s'attendre à une survie à 5 ans de 25%. Les patients qui présentent des métastases multiples limitées à un seul lobe peuvent aussi profiter d'une résection. Les métastases hépatiques étendues peuvent répondre à une chimiothérapie simple ou d'association. Les meilleurs taux de réponse sont obtenus par chimiothérapie administrée en perfusion dans l'artère hépatique mais on n'a pu démontrer d'amélioration nette de la survie. Les métastases pulmonaires solitaires ou limitées, quand elles ne sont pas reliées à d'autres atteintes métastatiques, devraient aussi être réséquées. Les atteintes de plusieurs organes peuvent répondre à une chimiothérapie systémique mais les résultats sont généralement mauvais. Un effet palliatif constitue un objectif important du traitement et suppose non seulement le traitement anticancéreux (chirurgie, chimiothérapie, radiothérapie), mais également des soins de soutien généraux.

From the Department of Surgery, Toronto General Hospital and University of Toronto, Toronto, Ont.

Presented as part of a symposium on the controversial aspects of colonic and rectal cancer at the 53rd annual meeting of the Royal College of Physicians and Surgeons of Canada, by the Royal College in cooperation with the Canadian Association of General Surgeons, Montreal, PQ, Sept. 13, 1984

Accepted for publication Mar. 25, 1985

Reprint requests to: Dr. B. Langer, Head, Division of General Surgery, Toronto General Hospital, Eaton Building 9-236, 101 College St., Toronto, Ont. M5G 1L7

The 5-year survival rate for resected primary colorectal cancer is approximately 50%, with prognosis being related to the stage of the disease. The liver is the commonest site of hematogenous spread and is involved in over 80% of patients who have metastatic disease.[1,2] One third of these patients have liver involvement only, the rest have widespread disease. Pulmonary involvement occurs in only about 10% to 15% of patients with metastases and is commoner in those with rectal cancer than in those with more proximal colonic lesions. Isolated single liver metastases are seen in 4% to 5% of these patients, and lung metastases in 1% to 2%. Considerable controversy remains regarding both the selection of treatment for metastatic colonic cancer and the expected results from such treatment.

Metastases to the Liver

In patients whose liver metastases are a part of widespread secondary disease, regional treatment of the liver other than for control of symptoms is inappropriate. When metastases are confined to the liver, regional therapy, consisting of either resection or hepatic infusion chemotherapy, can be considered. To assess the results of such therapy, detailed information on the natural history of the untreated disease is needed.

The expected survival of patients with liver metastases from colorectal cancer

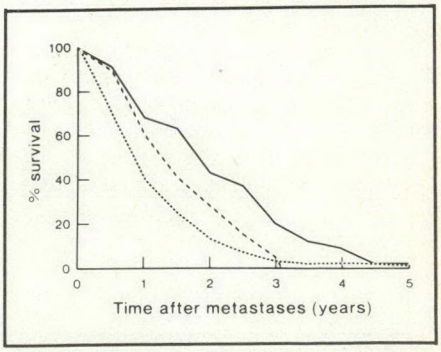


FIG. 1—Survival of 39 patients with solitary (solid line) hepatic metastases, 31 patients with multiple unilateral (broken line) hepatic metastases and widespread (dotted line) liver metastases, reported by Wagner and associates.[5]

varies, depending on the extent of liver involvement and presence or absence of other metastatic disease. The older reported data[3,4] suggest survival times of 6 to 9 months for such patients and have been used to support claims for effectiveness of new therapies that produce better mean survival in uncontrolled series. Clearly, the use of such unselected, unstaged historical data is inappropriate, since patients who are selected for either resection or infusion are usually those with regional disease and most often less advanced disease as well. If historical data are to be used for comparison, the disease must at least be staged; when this is done,[5] a difference in survival between patients with solitary, unilobar multiple, and widespread liver metastases is noted (Fig. 1). These data also show that without resection even patients with solitary metastases rarely survive for 5 years.

Resection of Liver Metastases

Primary and secondary hepatic tumours were resected as early as 1888.[6] Reports in the 1950s and 1960s indicated survival rates following resection for metastatic disease of approximately 20%.[7]

The technique of liver resection has been improved to the point at which major resections can be carried out with a mortality of 5% or lower.[8,9] It is also now widely accepted that the results of resection of liver metastases are as good with adequate regional resection as with formal anatomical lobectomy. The latter is performed only to obtain adequate tumour clearance and leave viable tissue. Critical to achieving this low morbidity and mortality are a good understanding of hepatic vascular and ductal anatomy, and sufficient experience in surgery of the liver.

Although many authors now report 5-year survival rates after resection of liver metastases ranging from 25% to 30%,[8,9] there remain differences of opinion regarding the results of synchronous versus metachronous excision of metastases, the importance of positive lymph nodes related to the primary disease, and the advisability of resecting multiple liver metastases. Virtually no one recommends liver resection in the presence of uncontrolled primary disease or other metastatic disease outside the liver.

In the past, the tradition was that metastases to either lung or liver should not be resected until the primary tumour was demonstrated to have been controlled and other metastases had not appeared.[10] Although many still hold this view with regard to lung metastases, liver metastases are usually treated more aggressively. In the extensive review of Foster and Berman,[8] no significant difference in survival was found between patients having resection of metastases discovered at the time of primary colonic resection or of those that appeared later. Wilson and Adson[9] did note better survival in metachronously resected secondary lesions but the results from both synchronous and metachronous excision were encouraging enough to warrant an aggressive approach in both situations.

The survival of untreated patients with solitary liver metastases is clearly better than in those with multiple metastases.[5] One would expect the same difference in the results of resection in these two groups of patients. However, the reported data do not clearly support this. Five-year survival reported by Wilson and Adson[9] clearly favours patients with solitary metastases. However, the data accumulated by Foster and Berman[8] showed no clear difference in 5-year survival between patients who underwent resection of single versus multiple metastases. Their study did not clearly separate the unilobar from bilobar multiple metastases and this may account for the favourable results.

Our experience with resection of hepatic metastases from various primary cancers, reported in 1983,[11] is outlined in Table I. The large number of formal anatomical resections reflects in part our earlier belief that lobectomy was the preferred operation for malignant disease of the liver. We are currently doing more segmental and wedge excisions wherever we can include adequate margins (at least 3 cm) of normal tissue.

Our actuarial survival curves (Fig. 2) are in keeping with data reported in the literature. We found a clear difference in outcome between solitary and multiple metastases, and we currently only resect multiple metastases if they are unilobar or, if multilobar, if they require only simple wedge excision. We found no difference in survival between patients with synchronous or metachronous metastatic disease.

Theoretically, about 2 of every 100 patients who undergo colonic resection for cancer have, or will have, solitary liver metastases and probably an equal number with unilobar multiple metastases will be suitable candidates for resection. It is therefore important to look carefully for such patients at the preoperative assessment, at operation for the primary tumour and during follow-up. Serial determinations of carcinoembryonic antigen and alkaline phosphatase levels, along with physical examination, are used in the follow-up of all patients who have cancer of the colon. If liver tumours are suspected, either ultrasonography or computerized tomography are carried out. When a tumour is deemed suitable for resection, nuclear scanning is also done, since it sometimes identifies multiple lesions missed by the other modalities. Angiography is always done preoperatively in patients thought to have resectable metastases, to show the vascular anatomy of the liver, and because it occasionally identifies patients with unresectable multiple lesions. When the metastatic tumour is large and centrally placed, hepatic venography is also used to show the position of the hepatic veins and to ensure that they can be cleared surgically.

Hepatic Infusion Chemotherapy

Because of the generally discouraging results of systemic chemotherapy in metastatic colonic cancer, the technique of infusion chemotherapy was developed to allow higher drug concentrations to be administered to the tumour area without a comparable increase in systemic toxicity. Hepatic artery infusion has been used since the 1950s, and in spite of technical improvements in drug delivery systems and the development of numerous regi-

Table I—Resection of Hepatic Metastases at the Toronto General Hospital From 1974 to 1982

Site of primary	No. of patients	Extent of resection	No. of patients
Colorectum	16	Extended right lobectomy	3
Adrenal	2	Right lobectomy	8
Terminal ileum (carcinoid)	1	Left lobectomy	2
Thyroid	1	Left lateral segmentectomy	1
Pancreas (islet-cell tumour)	1	Wedge excision	8
Abdominal wall (leiomyosarcoma)	1		

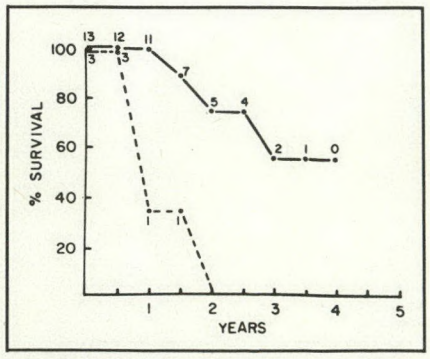


FIG. 2—Actuarial survival of 16 patients with colorectal cancer who had single (solid line) or multiple (broken line) hepatic metastases and underwent resection. (Reproduced from Taylor B, Langer B, Falk RE, Ambus U: *Can J Surg* 1983; 26: 215–7.)

mens of combination chemotherapy there is still no good evidence that infusion chemotherapy prolongs life in patients with liver metastases. Many authors report response rates of 50% or more, but most comparisons are with "historical" controls, and controlled trials have yielded equivocal results.[12] Infusion chemotherapy should be reserved for patients in whom systemic chemotherapy has failed, or for patients entering controlled trials.

Metastases to the Lung

The first collected series of cases in which metastatic disease of the lung was resected was reported in 1947.[13] Since then, many have confirmed that prolonged survival can be obtained following removal of lung metastases.[14,15] Secondary tumours from colon and rectum make up only about 20% of pulmonary metastases suitable for resection, unlike the liver where they are by far the commonest source of metastatic disease.

With modern surgical techniques and conservative segmental or wedge excisions, the morbidity and mortality of pulmonary resection for metastatic disease are low. Control of the primary disease and absence of other metastatic disease are necessary. Some still believe that patients with a long disease-free interval do better than those with synchronous metastases, but others have found no difference. Most workers are resecting multiple metastases in selected patients providing the lesions are few in number and resectable with little loss of lung parenchyma. In such patients there is no significant difference in survival compared with patients who undergo resection of solitary metastases. Five-year survival rates of about 25% can be expected after resection of colorectal metastases using the above criteria.

Unresectable Metastases

Aside from a small number of patients with isolated metastases to liver or lung, or with early local recurrences, surgical excision for cure is not possible in the majority of patients with colorectal metastases. The status of these remaining patients varies from the healthy asymptomatic individual with small multilobar metastases to the liver only to the moribund patient with widespread peritoneal, hepatic and other disseminated disease. In selecting from among treatment options in this heterogeneous group of patients, a number of principles should be kept in mind.

- Treatment is palliative only. There are many reports of excellent responses in symptomatic patients to a variety of therapies that in the individual case seem to prolong life as well as relieve symptoms; however, there is no good evidence that any given treatment regimen can predictably prolong survival.
- Treatment of asymptomatic patients with known disease, or patients with unproven metastatic disease but at a high risk for recurrence, can only be justified as part of a controlled clinical trial, because there is no good evidence that treatment of such asymptomatic patients either delays the onset of symptoms or prolongs life.
- Palliative treatment of the symptomatic patient should be based on detailed information of the natural history of the untreated disease, the side effects and risks of the proposed therapy, and reliable information regarding the expected response from the chosen therapy.
- The patient should participate fully and in an informed way in decisions regarding such therapy, with as full an explanation of the expected benefits and risks of medical therapy as one would carry out in patients who undergo surgical therapy.

The treatment options available for patients with unresectable metastatic disease include the following:

- Observation and supportive care. This is required in all, but particularly in those for whom specific antineoplastic treatment is not thought to be worthwhile. Therapy other than antineoplastic agents for relief of symptoms is as important in such patients as the antitumour therapy itself.
- Surgery should remain an option, even in incurable disease, when required for complications that can be corrected with a reasonable expectation of palliation, such as intestinal obstruction, bleeding and certain types of intractable pain.
- Radiotherapy is occasionally useful to control pain, especially in bony or pelvic recurrence.
- Systemic chemotherapy is indicated in patients with symptomatic, systemic, nonresectable disease, in patients who are in satisfactory nutritional state, and in those who are infection-free. Patients over the age of 70 years tolerate such chemotherapy poorly and selection of such treatment in this group of patients should be made with care. Acceptable drug regimens in order of increasing effectiveness, and also increasing toxicity, are 5-fluorouracil, 5-fluorouracil and mitomycin C, and 5-fluorouracil, mitomycin C and Adriamycin.
- Experimental therapy should be used only under carefully controlled conditions and as part of organized clinical trials. These include new combinations of chemotherapy, immunotherapy and hyperthermia.

Conclusions

The best opportunity for cure in colorectal cancer is through early diagnosis and adequate surgical excision. Careful follow-up of all patients is imperative since in a small number of those in whom recurrent disease develops, especially in the liver, the cancer may still be curable by surgical resection. The role of adjuvant therapy is still being defined. Chemotherapy for symptomatic unresectable metastatic disease should be selective, remembering that the objective is palliation, so that benefits may be maximized and morbidity minimized.

References

1. DIONNE L: The pattern of blood-borne metastasis from carcinoma of rectum. *Cancer* 1965; 18: 775–81
2. BROWN CE, WARREN S: Visceral metastasis from rectal carcinoma. *Surg Gynecol Obstet* 1938; 66: 611–21
3. JAFFE BM, DONEGAN WL, WATSON F, SPRATT JS JR: Factors influencing survival in patients with untreated hepatic metastases. *Surg Gynecol Obstet* 1968; 127: 1–11
4. PESTANA C, REITEMEIER RJ, MOERTEL CG, JUDD ES, DOCKERTY MB: The natural history of carcinoma of the colon and rectum. *Am J Surg* 1964; 108: 826–9
5. WAGNER JS, ADSON MA, VAN HEERDEN JA, ADSON MH, ILSTRUP DM: The natural history of hepatic metastases from colorectal cancer. A comparison with resective treatment. *Ann Surg* 1984; 199: 502–8
6. KEEN WW: Report of a case of resection of the liver for the removal of a neoplasm with a table of 76 cases of resection of the liver for hepatic tumours. *Ann Surg* 1899; 30: 267
7. WOODINGTON GF, WAUGH JM: Results of resection of metastatic tumours of the liver. *Am J Surg* 1963; 105: 24–9
8. FOSTER JH, BERMAN MM: Solid liver tumours. *Major Probl Clin Surg* 1977; 22: 1–342
9. WILSON SM, ADSON MA: Surgical treatment of hepatic metastases from colorectal cancers. *Arch Surg* 1976; 111: 330–4
10. PACK GT, BRASFIELD RD: Metastatic cancer of the liver; clinical problem and its management. *Am J Surg* 1955; 90: 704–16
11. TAYLOR B, LANGER B, FALK RE, AMBUS U: Role of resection in the management of metastases to the liver. *Can J Surg* 1983; 26: 215–7
12. GRAGE TB, VASSILOPOULOS PP, SHINGLETON WW, JUBERT AV, ELIAS EG, AUST JB, MOSS SE: Results of a prospective randomized study of hepatic artery infusion with 5-fluorouracil versus intravenous 5-fluorouracil in patients with hepatic metastases from colorectal cancer: a Central Oncology Group study. *Surgery* 1979; 86: 550–5
13. ALEXANDER J, HAIGHT C: Pulmonary resection for solitary metastatic sarcomas and carcinomas. *Surg Gynecol Obstet* 1947; 85: 129–46
14. PATTERSON GA, TODD TR, ILVES R, PEARSON FG, COOPER JD: Surgical management of pulmonary metastases. *Can J Surg* 1982; 25: 102–5
15. WRIGHT JO III, BRANDT B III, EHRENHAFT JL: Results of pulmonary resection for metastatic lesions. *J Thorac Cardiovasc Surg* 1982; 83: 94–9

ALFRED S. KETCHAM, MD, FACS*

4. The Management of Recurrent Rectal Carcinoma

Rectal carcinoma remains an enigma to surgical and medical oncologists. The chemo- and radiotherapeutic approaches have been fraught with failure, and when this happens the patient is left to the challenge of the surgical oncologist who sometimes must perform extensive re-resection to include adjacent structures. Experienced surgical judgement is assisted by preoperative and intraoperative criteria, which are contraindications to resection: preoperatively, they include metastases, fixation of tumour to pelvic wall, sciatica, obstruction of both ureters and leg edema. Intraoperatively, metastases within aortic nodes or beyond the pelvis and extension of disease laterally or deep to pelvic wall or to multiple loops of bowel are all contraindications. These tumours are often slow to metastasize so that aggressive local surgical resection is warranted to minimize the morbidity prone complications associated with low-lying perineal or pelvic recurrence of rectal cancer.

Le cancer du rectum demeure une énigme pour les oncologistes chirurgicaux et médicaux. La chimio et la radiothérapie débouchent trop souvent sur l'échec, et quand cela survient, le patient est laissé aux tentatives du chirurgien oncologiste qui doit parfois procéder à une deuxième résection large, touchant les structures adjacentes. Le jugement chirurgical expérimenté considère les critères préopératoires et opératoires qui déterminent les contre-indications de résection: en préopératoire on recherchera, les métastases, l'adhérence de la tumeur à la paroi pelvienne, une sciatique, l'obstruction des deux uretères et un oedème des membres inférieurs. Durant l'opération, les métastases des ganglions aortiques ou au-delà de la cavité pelvienne, et l'extension latérale ou profonde du cancer à la paroi pelvienne ou à plusieurs circonvolutions de l'intestin sont autant de contre-indications. Ces tumeurs sont souvent lentes à se métastasier de sorte qu'il est justifié de faire une résection locale aggressive pour réduire la morbidité et les complications des récidives pelviennes ou périnéales basses du cancer du rectum.

From the Department of Surgery, University of Miami School of Medicine, Miami, Fla.

**Professor of Surgery, Chief, Division of Oncology, University of Miami School of Medicine; Professor of Clinical Oncology, American Cancer Society*

Presented as part of a symposium on the controversial aspects of colonic and rectal cancer at the 53rd annual meeting of the Royal College of Physicians and Surgeons of Canada, by the Royal College in cooperation with the Canadian Association of General Surgeons, Montreal, PQ, Sept. 13, 1984

Accepted for publication Mar. 25, 1985

Reprint requests to: Dr. A.S. Ketcham, Department of Surgery, University of Miami School of Medicine, PO Box 016310, Miami, FL 33101, USA

Carcinoma of the colon and rectum is the only malignant lesion of the gastrointestinal tract to be associated with a substantial cure rate. However, it is distressing that the overall 5-year survival rate for colorectal cancer patients approximates only 42%. If the disease is diagnosed before symptoms develop, then the survival rate may reach 90%. It is difficult to understand how there can be only a 42% survival rate from a disease that is characterized early in its course by change in the diameter, colour or consistency of the stool, with or without associated dietary gastrointestinal disturbances. This failure of early recognition rests both with the patient and the physician. Certainly the American Cancer Society and other health-oriented groups have publicized the signs and symptoms of colonic cancer to the extent that the reading and viewing public should be aware that rectal bleeding may arise from something other than hemorrhoids. From the oncologist's standpoint, it is uncomfortable to realize the number of patients who, upon leaving the physician's office, have not had a digital rectal examination, or a guaiac test for occult blood in the stool.

Late recognition with an overall survival of less than 50% following primary treatment leads next to the problem of local failure. The recurrence of rectal cancer is, in part, due to lack of early recognition, but equally important, to inadequate or less than optimal initial treatment. Failure to recognize the extent of the disease, locally within the bowel, and the potential for spreading to other areas at the time of the original surgery, presents the surgeon with the challenge of treating recurrent disease as if it can be cured, not as if he will fail in 50% of patients. It is equally important that the extent of local disease or the identification of distant disease be recognized before the surgeon decides on the management techniques for proven recurrent cancer of the rectum. If the goal is symptomatic palliation because of pain, bleeding or tenesmus, then the expense, inconvenience and morbidity associated with a metastatic work-up may not be indicated. Before expensive and debilitating local surgery is undertaken, it is appropriate to establish the potential for cure by ruling out, if possible, the presence of liver, lung or distant lymph-node metastases. Computerized axial tomography, liver scanning, hepatocellular and hematochemical profiles and possibly lymph-node biopsy of groin or supraclavicular areas might all allow a better understanding of the state of the disease process.

Role of Therapy

The first question, then, must be related to the role of therapy for the recurrent colorectal cancer. Is it for potential cure? Is it for palliation (in the sense of relieving local symptoms)? Is it to delay the expected local recurrence, knowing that eventually metastases will develop if the disease process is allowed to continue unchecked? The final question that must be asked, particularly in the academic environment, is: Is therapy for study accrual based upon a randomized investigative protocol? It is with

these questions in mind that the surgeon must approach the local recurrence either with local resection, cauterization, fulguration, chemotherapy, radiotherapy, immunotherapy or the multidisciplinary use of two or more of these modalities.

Today there is a trend towards conservatism in treating many cancers, particularly in the lower colon and rectum. This trend has been associated with an alarming increase in recurrent disease being identified at intervals that in no way allow an opportunity for ultimate cure no matter how aggressive the therapy might be. It must be remembered that primary abdominoperineal resection can be performed with a mortality of 0% to 2%. Admittedly, the morbidity rates may reach 50%, but morbidity can be tolerated when one is dealing with a curative procedure. Unfortunately, colorectal cancer often extends laterally, requiring removal of the endopelvic fascia and the lymphatic and vascular structures associated with the lateral pelvic walls, and requires meticulous cleansing of the iliac vessel system. Posterior extension of the rectal tumour encroaching upon the sacrum may require primary or secondary partial sacrectomy. Unrecognized penetration anteriorly into the vagina or the prostate, bladder or urethra contributes to failure in patients being treated both primarily and secondarily. While there is great reservation about the value or need to remove the vaginal wall or the prostate at the time of primary colorectal surgery, there should be no hesitation in doing so when treating recurrent disease. I would minimize the role of local intervention with cauterization, fulguration or local resection in the *absence* of identified metastatic disease. It is only the experienced "conservatist" surgeon, using these techniques frequently, who can successfully obtain disease control through fulguration and other topical local therapy regimens.

Table I—Criteria Contraindicating Exploration for Recurrent Rectal Cancer

Metastases beyond the pelvis
Tumour fixation to pelvic wall or frozen pelvis unless there has been previous radiotherapy
Sciatic distribution of leg pain
Bilateral ureteral obstruction
Unilateral leg edema

Table II—Intraoperative Criteria Contraindicating Resection

Aortic node metastases
Lateral or deep pelvic wall extension
Direct extension to multiple loops of bowel
Metastases beyond the pelvis

Table III—Clinical Prognostic Findings

Finding	Survival
One ureter involved	Decreased
Unilateral leg edema	Markedly decreased
Sciatic pain	Markedly decreased
Pelvic wall fixation	Markedly decreased
Both ureters involved	None

Adjuvant Therapy

Trends in treatment suggest that adjuvant radiotherapy with aggressive local surgery results in a lower local recurrence rate, but when the disease does recur, the morbidity from repeat local resection is overwhelming. It is therefore mandatory that when adjuvant chemotherapy or radiotherapy is used primarily or secondarily, the surgeon must expect morbidity associated with progression of the disease, fistulization and urinary and bowel infection. When one uses adjuvant radiotherapy, chemotherapy or even immunotherapy to convert the nonresectable lesion into one that is potentially resectable, one is dealing in the realm of the unknown. Ordinarily, the extent of the procedure needed to bring disease under control after tumour shrinkage by adjuvant chemotherapy or radiotherapy should be identical to that required to bring about total tumour removal without adjuvant therapy. The diagnosis and management of recurrent cancer of the pelvic structures presents problems that do not have satisfactory solutions. The diagnosis is usually tentative as histologic confirmation may be difficult. The treatment is ineffective in producing cure in many cases. Pelvic recurrence occurs along the bony walls of the pelvis but seldom invades the bone until late in its development and causes pain by pressure, particularly on the nerves radiating usually down one leg. Pain associated with recurrent pelvic perineal cancer suggests non-resectable recurrence. Seldom is perineal or radiating pain associated with radiation fibrosis alone. Few studies have authoritatively documented any increase in survival associated with the treatment of recurrent rectal cancer using radiotherapy. Palliation may be obtained but survival related to distal disease is seldom altered. Distant metastases remain the major cause of death in patients with recurrent colorectal cancer.

Surgery for Cure

In the patient who is free of identified metastatic disease, the surgeon may decide to perform extensive local pelvic surgery that almost never preserves anorectal continence and seldom allows preservation of the bladder and prostate. The patient must be prepared for urinary diversion with an abdominally placed conduit as well as the usual colostomy for fecal diversion if necessary. This extensive surgery necessitates removal of all lymph-node-bearing tissue of the pelvic structures and often resection of the sacrum. When sacral resection must be undertaken, the surgeon should not transect above S3, for the dural sac extends to the middle or lower portion of S2. Fortunately, if the bladder can be left intact, bladder function is seldom impaired following partial sacrectomy. Urinary competence may be delayed, but eventually all patients will void normally.

Tables I and II briefly outline the preoperative and intraoperative criteria contraindicating surgical intervention and operative resection for cure. Table III outlines the prognostic significance of specific clinical findings when dealing with patients who have recurrent disease of the pelvic structures. While these criteria and prognostic findings are of great help, they must be interpreted selectively, depending upon other clinical manifestations in the individual patient.

Factors Contributing to Success

Several factors will contribute to success of surgery (Table IV). Cancer cells can be disseminated within the wound by instruments, gloves and rough operative technique. It is therefore essential that the wounds and adjacent structures be protected from tumour-cell contamination by one of the many new innovations in plastic wound drapes. Instruments must be adequately cleaned or changed frequently. The washing of one's gloves in a wash basin beside the operating table only leads to cells being washed off the gloves and potentially picked up by cross-contamination to the assistant's gloves

Table IV—Factors Contributing to Successful Resection

Wound protection	Elastic stockings
Instrument cleansing	Gastrostomy?
Absence of glove and instrument wash basins	Appendectomy?
	Experience
Antibiotics	Hemostasis (no packing)
Bowel sterilization	Obliteration of dead space
Pulmonary toilet precautions	Adequate drainage
Fresh blood?	Peritonealization
Early ambulation	Careful tissue handling

when he or she washes blood off. Minimizing infectious complications by thorough bowel preparation and adequate pulmonary precautions, with efforts to prevent thromboembolism, will all give a better opportunity for success. Technically, the obliteration of all dead space is mandatory, particularly in the surgical field that has been irradiated. Adequate drainage is essential and peritonealization is ideal but is seldom obtained. It has often been said that there is no right way to do the wrong thing. So often in the pelvic surgical intervention for recurrent cancer, poor judgement has been used in determining the feasibility of cure. Surgical aggressiveness in the irradiated lateral walls of the pelvis can lead to unrelenting immediate or delayed hemorrhage, particularly in the hands of the uninitiated surgeon.

Conclusions

While the median survival of 15 months is the accepted life span after diagnosis of local recurrence of cancer in the pelvis, this can be extended sometimes indefinitely to the point of cure, by selective surgical intervention. Surgeons should approach perineal recurrence aggressively for it is often curable. Pelvic recurrence, however, is seldom curable and it is never curable without a selectively aggressive attempt at resection. It is unfortunate that surgeons sometimes forget that the best way to avoid radical surgery is to perform major surgery at the first opportunity.

JAMES M. LANGEVIN, MD, FRCSC;* W. DOUGLAS WONG, MD, FRCSC, FACS†

5. What Is Appropriate Follow-up for the Patient With Colorectal Cancer?

Overall recurrence rates after curative resection for colorectal cancer average 30%. The value of intensive follow-up protocols is assessed from a review of the literature, which reveals that recurrent colorectal cancer can be detected at an earlier stage (average 3 months) and that repeat resection rates for cure can be increased (twofold or more) by intensive follow-up. Despite this, no improvement in survival has been documented. As nonsurgical modalities of therapy for recurrence become further refined, earlier detection of recurrent tumour will become increasingly important. An intensive follow-up regimen is therefore proposed, based on a knowledge of the patterns and timing of recurrence, the relative merits of the investigational modalities available and the assumption that at some point earliest detection and subsequent therapy will improve survival.

Dans l'ensemble, le taux de récidive après résection à visées curatives d'un cancer du côlon ou du rectum est en moyenne de 30%. On évalue à travers la littérature médicale, l'intérêt des protocoles comportant des examens de surveillance intensifs; on y constate que les récidives du cancer colorectal peuvent être décelées à un stade plus précoce (en moyenne de 3 mois) et que le nombre de deuxièmes résections à visées curatives peut être augmenté (pouvant être doublé ou davantage) grâce à des examens de contrôle fréquents. Néanmoins, on n'a pu démontrer aucune amélioration de la survie. Avec le perfectionnement du traitement non chirurgical des récidives, l'importance d'une détection précoce ira en augmentant. En conséquence, on propose un programme intensif d'examens de contrôle s'appuyant sur l'évolution et le délai caractéristiques des récidives, la valeur relative des différents examens disponibles et l'hypothèse, qu'éventuellement, une détection très précoce et le traitement subséquent amélioreront la survie.

From the Department of Surgery, Colonel Belcher Hospital and Tom Baker Cancer Centre, Calgary, Alta.

Presented as part of a symposium on the controversial aspects of colonic and rectal cancer at the 53rd annual meeting of the Royal College of Physicians and Surgeons of Canada, by the Royal College in cooperation with the Canadian Association of General Surgeons, Montreal, PQ, Sept. 13, 1984

**Consultant surgeon, Foothills Hospital, Colonel Belcher Hospital and Tom Baker Cancer Centre*

†Consultant surgeon, Colonel Belcher Hospital and Tom Baker Cancer Centre

Accepted for publication Mar. 25, 1985

Reprint requests to: Dr. J.M. Langevin, 305 Kensington House, 1167 Bowness Rd. NW, Calgary, Alta. T2N 3J6

Colorectal cancer is the second leading cause of cancer deaths in North America.[1] In Canada, the mortality from this disease has not changed over the last decade.[2] Approximately 6000 Canadians die annually of colonic and rectal cancer and in a further 6000 the disease is diagnosed.[2] Although two thirds of the latter group will undergo a curative resection, recurrent tumour will develop in about one third of them. The overall cure rate for colorectal cancer therefore is approximately 50%.

At present, adjuvant treatment has had no major impact on survival following curative resection. Early detection and surgical excision of recurrence currently offer the best hope for improved survival. What constitutes appropriate follow-up to detect recurrence at the earliest possible stage and of what value early detection is, are controversial.

This paper will focus on four basic aspects of follow-up. Where to look, when to look, how to look and why to look. A follow-up protocol is also recommended.

Risk, Pattern and Timing of Recurrence

The first two aspects of follow-up (where and when to look) must be based on our current knowledge of the risk factors, patterns and timing of recurrence.

Overall recurrence rates after curative resection for colorectal cancer average about 30% (Table I[3-6]). Stage at resection, site of the lesion, size of the tumour and patient age have consistently been found to correlate with an increased risk of recurrence. Those patients whose tumour has spread through the bowel wall are at greatest risk of recurrence. Of 285 patients who underwent curative resection at the Peter Bent Brigham Hospital in Boston, Malcolm and associates[4] reported an overall recurrence rate of 27%. Lesions penetrating the bowel wall, with or without positive lymph nodes, had the highest recurrence, 56% and 37% respectively. In this study patients less than 60 years old and those with tumours

larger than 4 cm in diameter were also at greater risk of recurrence.

A striking relation between the site of the primary tumour and recurrence rate has been demonstrated, with lesions in the sigmoid colon and rectum at greatest risk for recurrence.[4,7] In addition to having a higher overall rate of recurrence, patients with rectal and rectosigmoid lesions have a higher rate of local recurrence compared with those who have lesions of the proximal colon.[4,7,8] In a study of tumour recurrences demonstrated at "second-look" operations, Gunderson and Sosin[8] found that nearly 50% of recurrences from rectal cancer were local or regional failures alone. Local failure was a component in 92% of failures with only 8% having distant recurrences alone. Of the 129 patients with cancer of the large bowel located proximal to the sigmoid colon, Malcolm and associates[4] found no isolated local recurrence, but 88% distant recurrences. A similar difference in the pattern of recurrence between proximal and distal large-bowel cancers was demonstrated by Welch and Donaldson.[9] They found no isolated local recurrences in lesions proximal to the sigmoid colon but local failure was a component in 75% of patients with recurrence from sigmoid and rectal cancer. This increased recurrence rate is unrelated to stage, although local failure rates also correlate with the stage of the disease, increasing with advanced stage and occurring primarily in the tumour bed and adjacent structures.[10]

The timing of recurrence after curative resection is relatively constant; 40% to 50% of recurrences will be manifest during the first year after resection, 70% by the second year and 90% or more by the fourth year (Table II[6,8,9]). The high early recurrence rate in rectal cancer as demonstrated by Gunderson and Sosin[8] resulted from earlier detection by second-look operation, which was carried out in a high-risk group.

Late recurrence after curative resection for colorectal cancer is low and is primarily distant. Welch and Donaldson[9] found that only 7% of recurrences occurred after 5 years. Cass and associates[11] found only 6% of local recurrences after that time. Late recurrence also occurs in patients whose primary tumour is more confined. In the series of Welch and Donaldson, 33% of late recurrences occurred in patients whose primary tumour was classified as Dukes' A; this compared with an overall late recurrence rate of 14%.

In addition to late recurrence, follow-up programs must be designed to incorporate surveillance for metachronous lesions, which develop in approximately 3.5% of patients surviving resection for colonic and rectal cancer. The mean interval to detection of this tumour is about 11 years.[12]

Follow-up

A plethora of tests and examinations are available for screening patients who have undergone a curative resection for colonic and rectal cancer. To maximize their usefulness, the decision to carry out these tests must be based on what is known about location and timing of recurrence.

History and Physical Examination

History-taking and physical examination are essential in follow-up, since approximately 60% of patients will be symptomatic when the recurrence is diagnosed, even when the follow-up has been intensive.[13] A detailed history is more sensitive than physical examination in diagnosing recurrence. Of the 48 patients with recurrent cancer found at follow-up by Beart and O'Connell,[3] 41 (85%) had symptoms before or at the time the recurrent tumour was detected by physical examination, or biochemical or radiologic abnormalities. Only 16 (33%) had positive physical findings.[5] The value of the history and physical examination is limited by the fact that the recurrence is diagnosed late and only rarely can symptomatic patients have their lesion resected for cure. In a prospective study, assessing the value of intensive follow-up after curative resection for colonic and rectal cancer, Törnqvist and associates[13] found that in only 8% of symptomatic patients was the recurrence resectable for cure, compared with 39% of asymptomatic patients.

Hemoccult Test

Stool testing for occult blood is simple and inexpensive and is useful for detecting anastomotic recurrence and metachronous lesions. In terms of detecting recurrence, however, the yield from this test is low, because overall 90% of recurrences are non-mucosal.[3,13]

Endoscopy

The endoscopic procedures available for surveillance of recurrence are more sensitive for mucosal recurrence than either hemoccult test or barium enema examination.[14] They are both diagnostic and potentially therapeutic for metachronous lesions, but they carry the same limitation as the Hemoccult test in that the majority of recurrences are non-mucosal. Of the 240 patients followed up through colonoscopy by Nava and Pagana,[14] only 17 (7.1%) had mucosal recurrence. Fifty-one patients (21%) had a benign tumour resected and in 4.6% of them a metachronous cancer developed in the 4-year follow-up period.[14] Beart and O'Connell[3] found that in only 3 (23%) of 13 patients with pelvic recurrences after anterior resection could the recurrent lesion be detected by proctoscopy.

Biochemical Tests

These are used primarily to detect hepatic metastases. Kemeny and colleagues[15] evaluated prospectively the usefulness of several biochemical tests of hepatic function and carcinoembryonic antigen (CEA) levels in identifying patients with hepatic metastases. They found no single laboratory test that gave more than 65% accuracy in detecting hepatic metastases and no combination of tests increased this accuracy. Carcinoembryonic antigen, lactic dehydrogenase, alkaline phosphatase and alanine aminotransferase levels were, in that order, the most accurate of 13 laboratory tests studied. No patient with obvious liver metastases on physical examination was included in this study.[15]

Table I—Overall Recurrence Rates After Curative Resection for Colorectal Carcinoma

Series	No.	Recurrence no. (%)
Beart and O'Connell, 1983[3]	168	48 (29)
Malcolm and colleagues, 1981[4]	285	76 (27)
Cochrane and colleagues, 1980[5]	180	71 (39)
Berge and colleagues, 1973[6]	639	217 (34)

Table II—Rates (%) of Recurrence at Various Intervals After Curative Resection for Colorectal Carcinoma

Series	Interval, mo			
	6	12	24	48
Welch and Donaldson, 1978[9]	18	41	69	89
Berge and colleagues, 1973[6]	–	48	70	92
Gunderson and Sosin,* 1974[8]	42	–	80	99

*Rectal cancer only.

Radiologic Investigations

Of the conventional radiologic procedures, chest roentgenography continues to play an important role in detecting metastases. Approximately 50% of lung metastases detected on the chest film are asymptomatic and, of these, 50% or more will be resectable for cure with a 5-year survival of about 30%.[13,16] Intravenous pyelography in the past was used to determine pelvic recurrence but is of no value because by the time abnormalities are detected, recurrence is advanced and nonresectable. Double-contrast barium enema examination is of value in detecting anastomotic recurrence or metachronous lesions. It is most sensitive when a baseline study is available for comparison; however, it is less sensitive than colonoscopy.[14] It is a recommended procedure when colonoscopy is not available or is incomplete.

Imaging Techniques

Body imaging techniques are inappropriate for screening as they are expensive and time-consuming. Liver scanning and ultrasonography are both about 80% accurate in demonstrating liver metastases.[17] Computerized tomography is slightly more accurate[18] but its major impact has been in identifying pelvic recurrence.

Tumour Markers

Tumour markers will play an increasingly important role in the early detection of recurrence. Carcinoembryonic antigen is the most specific and sensitive of the tumour markers, levels being elevated in 75% of recurrences.[19] It is the first evidence of recurrence in 33% of patients when done on a monthly basis after curative resection and levels are elevated in 45% of patients before there is clinical evidence of recurrence.[19,20] In fact, this elevation can be detected as early as 6 months before there is any clinical evidence of recurrence.[21] Carcinoembryonic antigen, however, is a poor indicator of local recurrence.[22,23] It is most sensitive for disseminated disease and gives a high rate of both false-negative and false-positive results. At present, its greatest potential is in identifying patients who would benefit from a second-look operation.

Various other tumour markers are being investigated as alternatives or adjuncts to CEA. They include acute-phase reactive proteins,[24] Tennessee antigen,[25] carbohydrate 19-9 antigen[26] and tissue polypeptide antigen.[27] So far, none of these have superseded CEA. Although its clinical usefulness is not yet established,[28,29] radioimmunodetection using labelled antibody to CEA and other tumour markers may prove to be more useful in detecting recurrence than assay for tumour markers. An additional benefit is the localization of recurrence.

Second-Look Operation

The most aggressive approach aimed at identifying localized recurrence has been the second-look operation. Wangensteen and associates[30] initiated this concept to improve survival of patients at high risk for recurrence. Despite 12% and 20% salvage rates in the asymptomatic and symptomatic groups respectively, this approach did not gain wide acceptance because of the high false-negative laparotomy rate (50%) and the high mortality (10%).[31] By adopting a second-look approach on the basis of an elevated CEA, the high false-negative laparotomy rate seen with the second-look procedure alone can be greatly reduced.[32] Such operations have been shown to increase repeat resection rates for cure but, although selectivity is enhanced by determining the CEA level, the false-negative laparotomy rate is still about 12%.[33] Follow-up as yet is too short to demonstrate any increase in survival by this approach.

Rationale and Protocol for Intensive Follow-up

The prime rationale for intensive follow-up of the patient with colorectal cancer is to identify recurrences at a stage when they may be resected for cure and thus to improve overall survival. Repeat resection rates for cure vary in the literature from 2% to 20% but average about 10%.[13] This can be increased substantially by identifying recurrences early at an asymptomatic stage.[13,32] Increased survival by early detection of recurrence, however, has yet to be demonstrated. The 5-year survival following resection of recurrence for cure, detected by routine follow-up, averages about 30%.[9] Carcinoembryonic antigen-directed second-look operations appear to offer the greatest hope for increasing survival in patients with recurrence following curative resection. At Ohio State University, Martin and associates[32] have been involved in a program of CEA-directed second-look operations since 1972. In their retrospective series of 22 patients, the CEA level was determined every 3 to 6 months. Twenty-seven percent of patients in this group underwent resection for cure. This represents a twofold increase in the reoperation rate for cure over routine follow-up not using CEA.[13] In their prospective series which started in 1976, 38 patients underwent second-look operations based on a rise of the CEA level determined at 45 to 60-day intervals. Sixty-one percent of patients in this group had recurrent tumour resected for cure.

Early detection of recurrence is in itself important and is achievable with an intensive regimen. It will become increasingly important as nonsurgical therapeutic modalities are refined. Other benefits of a follow-up program include detection and treatment of metachronous lesions, an increased sense of patient well-being and the opportunity for ongoing therapeutic assessment.

Based on current knowledge of recurrence patterns, timing of recurrence and relative usefulness of available assessment modalities, a follow-up protocol is recommended (Table III). It includes history-taking, physical examination and Hemoccult test, colonoscopy, sigmoidoscopy and barium enema examination and chest roentgenography. Liver function tests should be repeated at each patient visit. The CEA level should be determined every 2 months for 2 years, every 4 months for 2 years, then every 6 months to 10 years. A second-look operation should be performed as necessary, based on the finding of an elevated CEA level. A metastatic work-up should be completed before operation to rule out incurable disease.

References

1. Third International Symposium on Colorectal Cancer. *CA* 1984; 34: 131

Table III—Follow-up Protocol for Patients With Colorectal Carcinoma

Procedure	Frequency
History-taking, physical examination and Hemoccult test	Every 3 mo for 2 yr, then every 6 mo for 2 yr, then yearly
Colonoscopy	At 3 mo if not done preop. Yearly for 4 yr then every 3 yr
Sigmoidoscopy	For rectal carcinoma as for history-taking
Barium enema examination	As for colonoscopy if former not available
Liver function testing	As for history-taking
Chest roentgenography	Every 3 mo for 2 yr, then every 6 mo for 10 yr
Determination of carcinoembryonic antigen (CEA) level	Every 2 mo for 2 yr, every 4 mo for 2 yr, then every 6 mo to 10 yr
Second-look operation	Based on CEA level, with or without confirmatory testing

2. *Cancer in Canada, 1980*, cat. no. 82-207, Department of Supply and Services, Statistics Canada, Ottawa, 1983
3. BEART RW JR, O'CONNELL MJ: Postoperative follow-up of patients with carcinoma of the colon. *Mayo Clin Proc* 1983; 58: 361–3
4. MALCOLM AW, PERENCEVICH NP, OLSON RM, HANLEY JA, CHAFFEY JT, WILSON RE: Analysis of recurrence patterns following curative resection for carcinoma of the colon and rectum. *Surg Gynecol Obstet* 1981; 152: 131–6
5. COCHRANE JPS, WILLIAMS JT, FABER RG, SLACK WW: Value of outpatient follow-up after curative surgery for carcinoma of the large bowel. *Br Med J* 1980; 128: 593–5
6. BERGE T, EKELUND G, MELLNER C, PIHL B, WENCKERT A: Carcinoma of the colon and rectum in a defined population. An epidemiological, clinical and post-mortem investigation of colorectal carcinoma and coexisting benign polyps in Malmö, Sweden. *Acta Chir Scand [Suppl]* 1973; 438: 1–86
7. UMPLEBY HC, BRISTOL JB, RAINEY JB, WILLIAMSON RC: Survival of 727 patients with single carcinomas of the large bowel. *Dis Colon Rectum* 1984; 27: 803–10
8. GUNDERSON LL, SOSIN H: Areas of failure found at reoperation (second or symptomatic look) following "curative surgery" for adenocarcinoma of the rectum. Clinicopathologic correlation and implications for adjuvant therapy. *Cancer* 1974; 34: 1278–92
9. WELCH JP, DONALDSON GA: Detection and treatment of recurrent cancer of the colon and rectum. *Am J Surg* 1978; 135: 505–11
10. WILLETT CG, TEPPER JE, COHEN AM, ORLOW E, WELCH CE: Failure patterns following curative resection of colonic carcinoma. *Ann Surg* 1984; 200: 685–90
11. CASS AW, MILLION RR, PFAFF WW: Patterns of recurrence following surgery alone for adenocarcinoma of the colon and rectum. *Cancer* 1976; 37: 2861–5
12. HEALD RJ, BUSSEY HJ: Clinical experiences at St. Mark's Hospital with multiple synchronous cancers of the colon and rectum. *Dis Colon Rectum* 1975; 18: 6–10
13. TÖRNQVIST A, EKELUND G, LEANDOER L: The value of intensive follow-up after curative resection for colorectal carcinoma. *Br J Surg* 1982; 69: 725–8
14. NAVA HR, PAGANA TJ: Postoperative surveillance of colorectal carcinoma. *Cancer* 1982; 49: 1043–7
15. KEMENY MM, SUGARBAKER PH, SMITH TJ, EDWARDS BK, SHAWKER T, VERMESS M, JONES AE: A prospective analysis of laboratory tests and imaging studies to detect hepatic lesions. *Ann Surg* 1982; 195: 163–7
16. CAHAN WG, CASTRO EB, HAJDU SI: Therapeutic pulmonary resection of colonic carcinoma metastatic to lung. *Dis Colon Rectum* 1974; 17: 302–9
17. SMITH TJ, KEMENY MM, SUGARBAKER PH, JONES AE, VERMESS M, SHAWKER TH, EDWARDS BK: A prospective study of hepatic imaging in the detection of metastatic disease. *Ann Surg* 1982; 195: 486–91
18. TEMPLE DF, PARTHASARATHY KL, BAKSHI SP, MITTELMAN AE: A comparison of isotopic and computerized tomographic scanning in the diagnosis of metastasis to the liver in patients with adenocarcinoma of the colon and rectum. *Surg Gynecol Obstet* 1983; 156: 205–8
19. NEVILLE AM, COOPER EH: Biochemical monitoring of cancer. A review. *Ann Clin Biochem* 1976; 13: 283–305
20. SUGARBAKER PH, ZAMCHEK N, MOORE FD: Assessment of serial carcinoembryonic antigen (CEA) assays in postoperative detection of recurrent colorectal cancer. *Cancer* 1976; 38: 2310–5
21. CARLSSON U, STEWÉNIUS J, EKELUND G, LEANDOER L, NOSSLIN B: Is CEA analysis of value in screening for recurrences after surgery for colorectal carcinoma? *Dis Colon Rectum* 1983; 26: 369–73
22. MOERTEL CG, SCHUTT AJ, GO VL: Carcinoembryonic antigen test for recurrent colorectal carcinoma. Inadequacy for early detection. *JAMA* 1978; 239: 1065–6
23. FINLAY IG, MCARDLE CS: Role of carcinoembryonic antigen in detection of asymptomatic disseminated disease in colorectal carcinoma. *Br Med J [Clin Res]* 1983; 286: 1242–4
24. WALKER C, GRAY BN: Acute-phase reactant proteins and carcinoembryonic antigen in cancer of the colon and rectum. *Cancer* 1983; 52: 150–4
25. GRAY BN, WALKER C, BARNARD R, BENNETT RC: Tennessee antigen: the predictive value of preoperative and postoperative assays in large-bowel cancer. *Dis Colon Rectum* 1982; 25: 539–41
26. KUUSELA P, JALANKO H, ROBERTS P, SIPPONEN P, MECKLIN JP, PITKÄNEN R, MÄKELÄ O: Comparison of CA 19-9 and carcinoembryonic antigen (CEA) levels in the serum of patients with colorectal diseases. *Br J Cancer* 1984; 49: 135–9
27. WAGNER W, HUSEMANN B, BECKER H, GROITL H, KOERFGEN HP, HAMMERSCHMIDT M: Tissue polypeptide antigen — a new tumour marker? *Aust NZ J Surg* 1982; 52: 41–3
28. KIM EE, DELAND FH, CASPER S, CORGAN RL, PRIMUS FJ, GOLDENBERG DM: Radioimmunodetection of colorectal cancer. *Cancer* 1980; 45(5 suppl): 1243–7
29. GOLDENBERG DM, KIM EE, BENNETT SJ, NELSON MO, DELAND FH: Carcinoembryonic antigen radioimmunodetection in the evaluation of colorectal cancer and in the detection of occult neoplasms. *Gastroenterology* 1983; 84: 524–32
30. WANGENSTEEN OH, LEWIS SJ, ARHELGER SW, MULLER JJ, MACLEAN LD: An interim report upon the "second look" procedure for cancer of the stomach, colon and rectum and for "limited intraperitoneal carcinosis". *Surg Gynecol Obstet* 1954; 99: 257–67
31. GOLIGHER JC: *Surgery of the Anus, Rectum and Colon*, 5th ed, Baillière Tindall, London, 1984
32. MARTIN EW JR, COOPERMAN M, CAREY LC, MINTON JP: Sixty second-look procedures indicated primarily by rise in serial carcinoembryonic antigen. *J Surg Res* 1980; 28: 389–94
33. CAREY LC, MARTIN EW: The second look for colon cancer. In NAJARIAN JS, DELANEY JP (eds): *Advances in Gastrointestinal Surgery*, Year Bk Med, Chicago, 1984: 603–8

Chairman's Comments

Although cancer of the colon and rectum has the highest cure rate of all cancers of the gastrointestinal tract, with an average 5-year survival for all grades of 50%, there are many aspects that still confound surgeons in their attempt to improve the cure rate. Surgery, except for a few modifications and refinements, has probably gone about as far as it can. Considerable effort is going into earlier diagnosis with patient education and further alerting the physician to the possibility of colorectal cancer. With the observation that the geographic distribution of colorectal cancer has changed, and the known deficiencies of roentgenographic investigation, the development and general use of colonoscopy has occurred fortuitously. Earlier diagnosis and especially the removal or identification of premalignant lesions should improve results. Time and study will show whether this optimism is justified.

With respect to the usual presentation of colorectal carcinoma, the standard procedures are the backbone of surgical treatment. In rectal carcinoma there has been some change with the advent of circular stapling devices, enabling more anterior resections to be carried out without the associated use of a colostomy so that multiple procedures and a permanent stoma have been eliminated in a substantial number of patients with rectal carcinoma.

Recurrence, of course, is still the spectre that looms in the wings following surgery for "cure". In about 50% of the patients with recurrence, the tumour will appear in the first 18 months after resection of the primary tumour and the remainder in 4 to 6 years. Much has been written on follow-up regimens that will improve earlier detection of recurrence. The initial optimism of tumour markers has not been borne out. The most universally used, carcinoembryonic antigen (CEA), has been found wanting because of false-negative and false-positive results of over 30% at some centres. It has been stated that by the time the CEA value reaches significantly positive levels — some 6 months before a clinical diagnosis can be made — the recurrence is unresectable. Even if attempted resection is accomplished, it seldom produces a cure. A search for more accurate and sensitive markers is necessary. In "second-look" procedures, the risk, cost and disease-free period has not been realized. Although much has been made regarding follow-up regimens, with early and repeated visits, and extensive investigation, the detection of early recurrence is generally disappointing and recurrent lesions so found are usually inoperable.

Computerized tomography provides more accurate information on extramural extension of postoperative malignant tumours in the pelvic region and may also give useful preoperative information on the extent of the tumour, nodal involvement and degree of invasion.

To approach the problem with measures other than surgery, adjuvant modalities such as chemotherapy, radiotherapy and immunotherapy have not really made significant changes in survival except in a palliative sense. Much work still is to be done before the possible benefits of such agents are realized. Thus, in spite of refinements in surgery and adjuvant therapy, the cure rate for cancer of the large bowel has not increased appreciably.

Early diagnosis, meticulous technique and standardization of surgical procedures may produce the best initial results. A great deal must still be done in the field of adjuvant therapy to increase the salvage rate.

With the advent of the stapling gun, more patients can undergo restorative resection without needing a colostomy, temporary or permanent, as Professor Goligher has noted. The upper one third of the colorectum presents no problem. But when the tumour lies in the middle and lower thirds, there is controversy over the procedure of choice. With the stapling technique, continuity can increasingly be restored.

Goligher has reviewed the various sphincter-saving operations and opts for the circular stapling device. Up to 75% of patients with rectal cancer can be treated by sphincter-saving resection; of these, 55% of procedures can be accomplished by hand-sewn techniques and 20% can be done only by stapling techniques.

Combined adjuvant chemotherapy in the form of local and regional chemotherapy, portal vein infusion chemotherapy and combined chemotherapy and radiotherapy has limited application in prolonging survival of patients with colorectal cancer, as Wolmark has pointed out. He reviews and analyses selected papers and protocols in adjuvant therapy for cancer of the large bowel. Although he draws no specific conclusions, it is apparent that the results have not improved statistically. Much work has yet to be done but at present colorectal cancer is resistant to this type of therapy.

The liver is the most common site of hematogenous spread of colorectal cancer. As Langer notes in his paper, it is involved in over 80% of patients with metastatic disease. One third have liver involvement exclusively, others have widespread dissemination, 4% to 5% have an isolated single metastasis of the liver and pulmonary metastasis occurs in 10% to 15%. Liver resection, when there is no other disease, can now be performed with approximately 4% to 5% mortality. The outcome in patients with solitary lesions is better than in those with multiple tumours. At one time the preference was a formal lobectomy but more segmental and wedge excisions are being performed, provided adequate margins of normal tissue can be obtained, and there are reports of 5-year survival after resection for liver metastasis ranging from 25% to 30%. Hepatic perfusion chemotherapy has given discouraging results. There is no good evidence that it prolongs life. In secondary pulmonary lesions in selected patients, the survival rate can be up to 25%. The author gives an excellent review of surgical options and requirements for the treatment of distant metastasis to liver and lung, as well as guidelines for the management of unresectable disease.

Dr. Ketcham recommends an aggressive approach to perineal recurrence and radical surgery initially but, like most surgeons, has found that recurrences are often distant and therefore incurable and that most local pelvic recurrences also have probably progressed to this state at the time of diagnosis.

Langevin in his paper describes the patterns of recurrence, which are most marked in sigmoid and rectal tumours, especially tumours more than 4 cm in diameter and those in patients younger than 60 years; these recurrences are more commonly local ones. Proximally placed tumours are associated with more distant metastasis. He provides a good review of some of the current thoughts on the natural history, incidence and follow-up for carcinoma of the large bowel. From his observations he recommends a postoperative protocol for follow-up of patients with colorectal carcinoma.

ROBERT H. THORLAKSON, MD, FRCS, FRCSC, FACS

Symposium chairman

Professor of Surgery,
University of Manitoba,
Winnipeg Clinic,
Winnipeg, Man.
R3C 0N2

D.H. HOSKING, MB, FRCS(EDIN), FRCSC;* I.M. MORROW, MD, FRCP;†
E.W. RAMSEY, MB, FRCS, FRCSC*

Percutaneous Removal of Upper Urinary Tract Calculi: Experience With Ultrasonic Lithotripsy

From October 1983 to March 1985, the authors removed upper urinary tract calculi percutaneously in 102 patients. In 89 patients, stones required disruption with an ultrasonic lithotriptor before removal. Fifty-two patients had a stone in the renal pelvis and 20 had calyceal stones only; 21 had stones at both sites and 9 had a stone in the upper ureter. Complete removal of all stone material was achieved in 67 of 68 patients with a solitary calculus, in 13 of 26 with multiple calculi and in 6 of 8 with ureteric calculi. Complications were minimal; three patients had pulmonary edema postoperatively as a result of excessive absorption of irrigating fluid, and one patient sustained a perforation of the descending colon. The mean postoperative hospital stay was 6.8 days and patients were able to return to work a few days after their discharge from hospital.

Percutaneous stone removal is a safe and effective procedure and is the surgical procedure of choice for the removal of upper urinary tract calculi.

D'octobre 1983 à mars 1985, les auteurs ont retiré par voie percutanée, des calculs des voies urinaires supérieures chez 102 patients. Pour 89 patients, les calculs ont dû être brisés à l'aide d'un lithotriteur à ultrasons, avant d'être enlevés. Cinquante-deux patients avaient des calculs du bassinet rénal alors que 20 avaient des calculs caliciels seulement; 21 avaient des calculs logés aux deux sites à la fois alors que pour 9, le calcul était logé dans la partie supérieure d'une uretère. L'enlèvement complet de toute substance calculeuse a pu être réussi chez 67 des 68 patients qui avaient un seul calcul, chez 13 des 26 patients qui avaient des calculs multiples et chez 6 des 8 patients qui avaient des calculs urétéraux. Les complications furent rares: trois patients souffrirent d'un oedème pulmonaire postopératoire résultant de l'absorption excessive du liquide d'irrigation, et un patient a subi une perforation du côlon descendant. La durée moyenne du séjour hospitalier postopératoire a été de 6.8 jours et les patients ont pu reprendre leur travail quelques jours après avoir reçu leur congé de l'hôpital.

L'enlèvement des calculs par voie percutanée est une intervention sûre et efficace et c'est l'opération de premier choix dans les cas de calculs des voies urinaires supérieures.

Removal of an intrarenal calculus through a percutaneous nephrostomy tract was first described in 1976.[1] The subsequent development of an ultrasonic lithotriptor has made it possible for the urologist to disrupt intrarenal calculi before removal. Following encouraging early reports from Europe,[2,3] percutaneous ultrasonic lithotripsy was introduced into the United States in late 1981.[4,5] We report our experience since October 1983, at the Health Sciences Centre in Winnipeg, using percutaneous techniques with or without ultrasonic stone destruction to remove renal and upper ureteric calculi.

Patients

From October 1983 to March 1985, 102 patients (65 men, 37 women) with symptomatic upper urinary tract calculi or calculi associated with obstruction or persistent urinary infection underwent percutaneous stone removal. During the period of this report, no patient underwent open surgery for an upper urinary tract calculus without first undergoing an attempt at percutaneous removal. The mean age of the patients was 51.1 years (range from 20 to 85 years).

Fifty-two patients had a stone in the renal pelvis and 20 had calyceal stones only. Twenty-one patients had stones in both the renal pelvis and calyces and in 7 of these patients the stones were branched pelvic calculi associated with separate calyceal calculi. Nine patients had ureteric calculi. Thirteen patients had urinary infection with urea-splitting organisms; in all the calculus was thought to have developed secondary to the urinary infection (i.e., struvite stone).

Methods

On the day before stone removal, percutaneous nephrostomy is performed under local anesthesia. Using fluoroscopic control, this is done through the calyx, decided upon in advance as the most appropriate for stone removal. Through this nephrostomy tract a no. 6 French angiocatheter is inserted down the ureter almost to the bladder and the exterior end is connected to a drainage bag. The patient returns to the ward and has the stone removed usually under general anesthesia on the following day.

Technique

For stone removal, the patient is placed in the prone position on a fluoroscopic table. A 0.038-inch torque guide wire is passed through the nephrostomy tube down the ureter into the bladder. The nephrostomy tube is removed and a 1-cm incision made adjacent to the guide wire. Flexible fascial dilators are used to dilate a tract to 12 French at which stage a double lumen catheter is used to introduce a second wire down the ureter. This second wire is needed to provide a means of gaining access back into the renal pelvis

*From the *Department of Surgery (Urology) and †Department of Radiology, Health Sciences Centre and University of Manitoba, Winnipeg, Man.*

Accepted for publication May 21, 1985

Reprint requests to: Dr. D.H. Hosking, Rm. GE446, Health Sciences Centre, 700 William Ave., Winnipeg, Man. R3E 0Z3

should the operating nephroscope be displaced from the renal pelvis during the procedure. The tract around one of the guide wires is then dilated to 24 French, which is large enough to permit the introduction of the operating nephroscope sheath into the renal pelvis. Tract dilatation and nephroscope insertion are performed under fluoroscopic control. In a few patients, a balloon catheter has been used to dilate the tract instead of flexible fascial dilators. A special pump is used to inflate the balloon to 30 French at a pressure of 12 atmospheres and a manometer is required to monitor the pressure and minimize the risk of balloon disruption. Despite the size of the balloon, it is usually necessary to pass at least one or two flexible dilators as well to create a suitable tract.

Recently, the tract has been dilated to between 24 French and 30 French, and once the largest dilator has been inserted, a rigid plastic sheath (Amplatz sheath), which fits closely over the dilator, is passed over it into the renal pelvis under fluoroscopic control. The dilator is then removed and the nephroscope passed into the renal pelvis through the sheath.

Small stones may be removed by grasping forceps under direct vision. Larger stones require disruption by an ultrasonic probe before removal. The stone may be broken into smaller pieces and removed with forceps or the stone may be completely disintegrated and the gravel aspirated through the hollow core of the ultrasonic probe which is attached to continuous suction. During the procedure, the renal pelvis is continually irrigated with normal saline, which either passes down the ureter or is removed by suction applied to either the probe or the nephroscope. An accurate record of fluid inflow and outflow is essential because the irrigating fluid may be absorbed, in which case the procedure must be terminated to prevent excessive absorption.

When all stone fragments have been removed, a stone basket catheter is passed to remove any small fragments that may have been flushed down the ureter. A plain film is taken and if this shows complete stone removal then a no. 20 French catheter is passed through the nephroscope sheath into the renal pelvis and the nephroscope is removed. A nephrostogram is obtained through the nephrostomy tube and, if it is satisfactory, the tube is sutured to the skin and connected to drainage. In patients who have undergone extensive ureteric instrumentation or who have sustained possible injury, a no. 6 French polyethylene catheter is passed down the ureter over the spare guide wire which is then removed. This is also of value when the possibility of residual calculus exists, as it will permit more ready access to the renal pelvis for repeat nephroscopy.

On the following day, a plain film of the kidney and a nephrostogram are obtained. If there is no evidence of residual stone, contrast extravasation or ureteric obstruction, and the calculus was uninfected, the nephrostomy tube is clamped. If this does not cause pain or fever, the tube is removed and the patient is usually discharged from hospital either on the same or the following day. No restrictions on activity are recommended apart from avoiding violent physical activity for approximately 6 weeks. Most patients can return to work within a week of stone removal.

In patients with infected renal calculi, in whom the nephrostogram shows free drainage of contrast down the ureter into the bladder, the renal pelvis is irrigated with Solution G (citric acid) for 48 hours even when stone removal is thought to be complete. This is done to dissolve any small residual fragments which, if left, would predispose to further stone formation.

Results

Sixty-eight patients had a single renal calculus either in the renal pelvis or in a calyx. Complete removal of all calculous material was achieved in 67 (99%). In one patient with a large, branched, upper-pole calculus, a small fragment migrated into a lower calyx and could not be retrieved. This fragment subsequently passed down the ureter spontaneously and renal tomograms showed no evidence of renal calculi 6 months postoperatively. Twenty-six patients had multiple renal calculi; in 13 of them, all calculi were removed. In 10 others, small fragments were identified on plain films taken at the end of the lithotripsy procedure. In all these patients the fragments were situated in calyces that could not be reached with the rigid nephroscope or it was considered that the calculi were not sufficiently large to justify risking renal damage to remove them. In three patients with large branched calculi, a substantial amount of stone material remained at the end of the procedure. In all three patients, second nephrostomies were placed in an attempt to remove all the stone material but in none was it possible to clear the kidney completely of the stone material. Of eight patients with ureteric calculi, the stones were completely removed in six. In both failures, the stone could not be engaged in a basket in order to manipulate it into the renal pelvis. One of these patients had had three previous ureterolithotomies involving the affected ureter.

In 89 of our first 94 patients, ultrasonic stone disruption was required. In the last eight patients in whom an Amplatz sheath was inserted before removing the stone, disruption was not necessary.

Postoperatively, 22 patients had a fever with body temperatures greater than 38.5°C. In eight of these patients the fever was a single temperature spike and in nine others the calculus was associated with urinary infection preoperatively. Following removal of the nephrostomy tube, 15 patients experienced urine leakage from the nephrostomy tract for longer than 24 hours. This resolved spontaneously in 14 of them. In one patient a ureteric stent was required for 48 hours. Three patients in our series suffered from pulmonary edema during the procedure. None of the three had an identifiable pelvic rupture. In two of them metabolic acidosis developed with a profound drop in blood bicarbonate concentration. A third patient did not have pulmonary edema but did have metabolic acidosis. In one patient the descending colon was perforated. The perforation was detected the day after stone removal when a nephrostogram showed drainage of contrast into the descending colon. This patient required repair of her colon and a temporary transverse colostomy. Four patients experienced gross hematuria after their discharge from hospital. Three of them had a single painless episode of between 1 and 2 weeks after their discharge from hospital, while the fourth patient required readmission to hospital 6 days after discharge for hematuria that had persisted for 24 hours. This patient was treated with hydration and bed rest. The hematuria stopped within 48 hours and did not recur.

The mean postoperative hospital stay for all our patients was 6.8 days. Those with infected renal calculi required longer hospitalization as in these patients we routinely irrigate the kidney with Solution G for a minimum of 48 hours postoperatively to try and dissolve any remaining fragments even if none are identified radiologically. If the 20 patients with infected calculi, and the 2 who required open surgery for stone removal, are excluded, the mean postoperative hospital stay in the remaining 80 patients was 5.3 days.

Stone analysis was available in 73 of the patients. Nineteen (26%) stones were calcium oxalate, and 35 (47.9%) both calcium oxalate and calcium phosphate. Eight patients (11%) had stones containing magnesium ammonium phosphate (struvite) and seven patients (9.6%) had pure calcium phosphate stones. One stone was reported as being pure calcium carbonate and one as calcium acid urate. One stone was reported as consisting of pure uric acid and the remaining stone was a mixture of calcium oxalate and uric acid.

Discussion

Percutaneous stone removal can no longer be considered experimental. Our success rate with the procedure is com-

parable to that of others[6,7] and we have found the complications associated with the procedure acceptable. One of our most serious complications, pulmonary edema, was likely related to systemic absorption of irrigating fluid, and has not been a problem since we adopted the practice of strict monitoring of fluid balance intraoperatively. It is important to note that in no patient who had pulmonary edema was a rupture of the renal pelvis identified intraoperatively. Frequently, at the end of one of these procedures, inspection of the peripheral calyx through which the nephrostomy has been performed reveals a small rupture of the renal pelvic wall deep within the renal sinus, and it is possible that this was the site of fluid absorption in our patients.

In some patients early in our series, the guide wire was inserted on the day of lithotripsy under the same general anesthetic. In this situation, it is difficult to be sure that no bowel lies between the kidney and the skin puncture site. The patient who sustained a bowel perforation in our series had the wire placed under general anesthesia immediately before lithotripsy. All guide wires are now placed under local anesthesia. The patient is asked to rotate on the fluoroscopy table during the wire placement and, with the kidney visualized from a lateral viewpoint, any bowel lying close to the kidney can be avoided.

Excessive bleeding has not been a problem. Two patients received one unit of packed cells each. In one patient there was brisk bleeding from the nephrostomy tube postoperatively, so the tube was clamped to stop further bleeding by tamponade secondary to blood clot forming in the renal pelvis; this maneuver was successful.

Stone fragments were retained in few patients. A plain film of the kidney at the end of the procedure is essential since fluoroscopy is not sensitive enough to detect small fragments. If there is any suspicion of retained fragments, the renal pelvis should be reinspected carefully, and another roentgenogram obtained if necessary. In some patients, retained fragments are identified postoperatively; if the fragments are thought to be accessible, nephroscopy should be repeated.

In patients with multiple stones, residual stone material was identified in 13 of 26 patients. However, 10 of these were considered to have a successful outcome in that the stone causing the symptoms was completely removed and all associated stones considered large enough to cause symptoms were also removed. In 10 of the 13 patients with residual stones, the fragments were considered inaccessible to the rigid nephroscope or the risk of renal injury was considered too high to justify attempting to remove the fragments. In most of these patients it is possible that even with open surgical procedures these stones might not have been removable. In recent cases use of a flexible nephroscope has made retrieval of small calyceal stones possible, and in one case use of the flexible nephroscope coupled with electrohydraulic stone disruption made it possible to remove a calculus that would not have been accessible with the rigid nephroscope.

The nephrostomy tract may be dilated in various ways before removing the stone and the technique used may influence the speed and method of stone removal. For most of our patients (94 of 102), the tract was dilated to 24 French and the nephroscope inserted into the renal pelvis without using an Amplatz sheath. The instrumentation channel in this instrument is 4.1 mm in diameter and as most renal calculi requiring removal are larger than this, ultrasonic disruption is usually required. The technique also carries the risk of fluid absorption so fluid balance must be carefully monitored. An advantage of the technique is that the renal collecting system is distended, making it easier to identify the intrarenal anatomy and find stone fragments. Also, the nephroscope is more easily maneuvered than when it is inside a separate sheath, and this may facilitate at least the initial disruption of large branched calculi. The Amplatz sheath system involves dilating the tract up to as much as 30 French and passing a rigid plastic sheath over the largest dilator used into the renal pelvis. The nephroscope or a visual grasping forceps can then be passed through the sheath and the stone either lifted out or disrupted. Stones up to 1 cm in diameter can be lifted out and in all eight patients in whom we have used this technique, stone disruption was unnecessary. Irrigating fluid is able to leak around the nephroscope, reducing the risk of fluid absorption and possible pulmonary edema. For better visualization of the collecting system, a cap can be fitted over the sheath and the nephroscope passed through a hole in the cap. This seals the system, allowing distension of the collecting system, and is useful particularly when performing flexible nephroscopy. Balloon dilatation of the tract using strengthened balloons is relatively simple and probably less traumatic than serial dilators. The balloons are expensive and we have found them suitable for one or two dilatations only. Moreover, we have found it necessary to pass one or two of the larger dilators as well to create a suitable tract, so balloon dilatation does not possess any major advantage over flexible fascial dilators. Rigid metal coaxial dilators were used in one of our patients. A thin metal tube is passed over the guide wire into the renal pelvis and serial metal dilators of increasing size are passed over the preceding one. This is useful in patients who have undergone previous renal surgery in whom dense scar tissue surrounding the kidney makes other forms of dilatation difficult.

Percutaneous stone removal is not a quick procedure. The average operating time was 101 minutes. Also, the urologist must be prepared to take the time to reinspect the renal pelvis if intraoperative roentgenograms suggest retained fragments, and be willing to subject the patient to multiple procedures in order to achieve complete clearance of stone material.

Despite the difficulties associated with percutaneous stone removal, the procedure has major advantages over conventional open surgical techniques. A 1-cm incision is required rather than the large muscle-dividing incision needed for open surgery and postoperative discomfort associated with the small incision is rare. The duration of postoperative hospitalization is substantially reduced. Patients are allowed to eat their normal diet as soon as they have recovered from the anesthetic and are not confined to bed postoperatively. A prolonged convalescence at home following discharge from hospital is not necessary and we advise patients that they may return to work within a week of stone removal. One patient returned to work directly from the hospital 72 hours after the procedure.

We consider percutaneous stone removal with or without stone disruption to be the surgical procedure of choice in the management of renal calculi. The introduction of extracorporeal shockwave techniques may reduce the need for percutaneous stone surgery in the future. Nevertheless, the modest cost, availability, effectiveness and safety of percutaneous stone surgery will ensure a continuing role for this technique in the management of renal calculi.

References

1. FERNSTRÖM I, JOHANSSON B: Percutaneous pyelolithotomy. A new extraction technique. *Scand J Urol Nephrol* 1976; 10: 257–9

2. ALKEN P, HUTSCHRENREITER G, GÜNTHER R, MARBERGER M: Percutaneous stone manipulation. *J Urol* 1981; 125: 463–6

3. WICKHAM JE, KELLET MJ: Percutaneous nephrolithotomy. *Br Med J [Clin Res]* 1981; 283: 1571–2

4. SEGURA JW, PATTERSON DE, LEROY AJ, MCGOUGH PF, BARRETT DM: Percutaneous removal of kidney stones. Preliminary report. *Mayo Clin Proc* 1982; 57: 615–9

5. KAHN RI: Nonsurgical technique for removal of upper urinary tract stones. *Contemp Surg* 1983; 22: 35–8

6. WHITE EC, SMITH AD: Percutaneous stone extraction from 200 patients. *J Urol* 1984; 132: 437–8

7. CLAYMAN RV, MILLER RP, SURYA V, CASTANEDA-ZUNIGA WR, SMITH AD, AMPLATZ K, LANGE PH: Nephrostolithotomy: percutaneous removal of renal and ureteric calculi. *Br J Urol Suppl* 1983: 6–10

J.M.A. BOHNEN, MD, FRCSC;* A.G. MATLOW, MD, M SC, FRCPC;†
M.M. COHEN, MB, CH B, FACS, FRCS(EDIN), FRCSC‡

Pseudomembranous Colitis and Wound Infection Following Perioperative Use of Multiple Antibiotics

The prophylactic use of antibiotics in elective surgery of the colon is accepted practice, but it has inherent risks. The authors report the case of a 70-year-old woman who had wound infection and severe, relapsing pseudomembranous colitis due to *Clostridium difficile* after a short course of antibiotics given orally and parenterally at the time of elective resection of the colon. Perioperatively, she received erythromycin base and neomycin orally, plus netilmicin and metronidazole intravenously. Although the concomitant administration of parenteral antibiotics may enhance the benefit of antibiotics given orally before operation, this does not entirely prevent wound infection. Until the relation between the number of drugs and risk of antibiotic-associated colitis is more clearly defined, caution should be exercised in the use of multiple antibiotics in elective colonic surgery.

En chirurgie non urgente du côlon, l'usage prophylactique des antibiotiques est une pratique acceptée, mais elle comporte des risques inhérents. Les auteurs décrivent le cas d'une femme de 70 ans qui a présenté une infection de plaie et une colite pseudo-membraneuse sévère et récidivante à cause de *Clostridium difficile* après avoir reçu par voies orale et parentérale un traitement antibiotique de courte durée au moment d'un résection non urgente du côlon. En peropératoire, elle avait reçu de l'érythromycine base et de la néomycine par voie orale, suivies de nétilmicine et de métronidazole en intraveineuse. Même si l'administration d'antibiotiques par voie parentérale est susceptible d'améliorer les effets des antibiotiques oraux donnés avant l'intervention, ceci ne protège pas entièrement des infections de plaie. Jusqu'à ce qu'on connaisse mieux le rapport entre le nombre de médicaments administrés et le risque de colite médicamenteuse, des précautions s'imposent dans l'emploi d'antibiotiques multiples lors de chirurgies coliques non urgentes.

*From the *Department of Surgery, and †Department of Medicine, The Wellesley Hospital and ‡Department of Surgery, Mount Sinai Hospital, and University of Toronto, Toronto, Ont.*

Accepted for publication May 21, 1985

Reprint requests to: Dr. J.M.A. Bohnen, Ste. 204, E.K. Jones Building, The Wellesley Hospital, 160 Wellesley St. E, Toronto, Ont. M4Y 1J3

Prophylactic administration of antibiotics in elective gastrointestinal surgery is a two-edged sword. Clarke and colleagues[1] have shown that antibiotics reduce the incidence of postoperative wound infections in colorectal surgery; however, there is a risk of drug complications that include antibiotic-associated colitis.[2] Can a zero wound infection rate be achieved in colonic surgery and, if so, would this be paid for by more frequent colitis? The relations between the number of antibiotics given perioperatively, the incidence of wound infection and of colitis have not been determined. We report on a patient who had a wound infection and severe pseudomembranous colitis after receiving a short course of four antibiotics in association with elective colectomy.

Case Report

A 70-year-old woman underwent left hemicolectomy to remove an adenocarcinoma of the splenic flexure. Her past history included cholecystectomy, hysterectomy and hiatal hernia repair. She had been taking hydrochlorothiazide for mild hypertension.

Preoperatively, the bowel was mechanically cleansed with oral magnesium citrate catharsis and saline enemas. The day before operation the patient was given neomycin and erythromycin base orally, 1 g each at 13,00. 16,00 and 23,00 hours; neither of these drugs was given postoperatively. She also received netilmicin (80 mg) and metronidazole (500 mg) intravenously 1 hour before operation. Two further doses of each of these drugs were administered over the next 16 hours (netilmicin) and 20 hours (metronidazole). The operation was prolonged (2 hours, 40 minutes) because of extensive adhesions due to previous surgery and diverticular disease.

The patient did well initially, but on day 9 following operation, watery diarrhea and abdominal cramps developed and she had a temperature of 39°C. Sigmoidoscopy revealed mucus, pus and pseudomembranes. The stool contained a heavy growth of *Clostridium difficile* and stool filtrate contained a toxin cytopathic to McCoy cells to a titre of 1:50 000 and neutralized by antitoxin to *Clostridium sordellii* toxin. The organism was sensitive to metronidazole, one of the antibiotics that had been given perioperatively.

On the day that diarrhea developed, the patient's wound was noted to be inflamed. Wound exudate contained a heavy growth of *Staphylococcus aureus* resistant to erythromycin. Sensitivity to netilmicin was not tested. A light growth of *Pseudomonas aeruginosa*, sensitive to netilmicin, was also cultured. The wound was opened and drained and did not cause further morbidity.

The patient was given vancomycin (500 mg orally every 6 hours) for 9 days. This controlled her intestinal symptoms and eradicated both the *C. difficile* and its toxin from the stool. Two days after withdrawing the vancomycin, the patient was discharged from hospital. Thirteen days later she was readmitted because of explosive watery diarrhea, fever and anorexia. Barium enema revealed pancolitis. Vancomycin was restarted orally, followed by bacitracin 100 000 units orally four times a day. Various drug combinations, including cholestyramine and metronidazole, were tried with little success. Over the next 2 months, toxin-positive diarrhea continued and was complicated by hypovolemia, metabolic acidosis and malnutrition requiring parenteral alimentation. She was discharged 2 months after readmission, still taking cholestyramine and bacitracin, but with the diarrhea under control.

Four months after her diarrhea began, the patient was admitted a third time for a right upper lobectomy to remove an adenocarcinoma of the lung. This had been detected shortly before her colectomy. Despite continued therapy, her stool was still positive for *C. difficile* toxin. Her postoperative course was uncomplicated this time, and the colitis resolved completely after several weeks' further therapy with bacitracin and cholestyramine.

Discussion

Colitis associated with the perioperative administration of antibiotics has not been adequately investigated. Keighley and associates[2] in their prospective study found that of 81 patients who underwent colorectal operations, 39 (48%) suffered from diarrhea postoperatively and 8

(10%) had *C. difficile* toxin in the stool. Their report does not say how many patients had colitis. The actual frequency of this complication is unknown, and would require prospective analysis of a large number of colorectal procedures. Unfortunately, there is no way at present to predict which patients are at high risk for the subsequent development of colitis.

The patient in this report had two postoperative infections (wound and colitis) caused by three bacteria. Two of these organisms (*C. difficile* and *P. aeruginosa*) were sensitive to at least one of the antibiotics given before operation. The *S. aureus* was resistant to erythromycin; its sensitivity to netilmicin was not tested. Although the wound infection caused little disability, the colitis was a major insult.

Neomycin and erythromycin base given orally before operation are effective in reducing the number of wound infections following colonic surgery. However, Clarke and colleagues[1] found that these antibiotics do not sterilize the colonic lumen and do not completely prevent wound infection. Coppa and associates[3] showed that a parenteral agent added preoperatively conferred increased benefit. It is therefore not unreasonable to augment oral prophylaxis with systemic antibiotics. However, this means that at least three antibiotics must be given and, as demonstrated by our case, they may still not prevent wound infection. Shapiro and coworkers[4] found that prolonged surgery is as important in the development of wound infection as the administration of antibiotics.

It is interesting that *C. difficile*, the organism implicated in the cause of antibiotic-associated colitis, was sensitive to metronidazole. Orally administered metronidazole is an effective treatment for colitis due to *C. difficile*,[5] and intravenously administered metronidazole is secreted into the colonic lumen.[6] One might assume, therefore, that orally or intravenously administered metronidazole should protect against colitis. However, most isolates of *C. difficile* are sensitive to the drug that caused the colitis,[7] and metronidazole itself has been implicated as a cause of antibiotic-associated colitis.[8] In Keighley's study,[2] patients who suffered diarrhea associated with *C. difficile* toxin had received kanamycin and metronidazole (the route of administration was not described). Metronidazole does not appear to protect against antibiotic-associated colitis.

The relation between the number of drugs given perioperatively and the incidence of colitis requires further study. This case is a warning that caution should be exercised in the use of multiple antibiotics in elective surgery of the colon.

References

1. CLARKE JS, CONDON RE, BARTLETT JG, GORBACH SL, NICHOLS RL, OCHI S: Preoperative oral antibiotics reduce septic complications of colon operations: results of a prospective, randomized, double-blind clinical study. *Ann Surg* 1977; 186: 251–9

2. KEIGHLEY MRB, BURDON DW, ALEXANDER-WILLIAMS J, SHINAGAWA N, ARABI Y, THOMPSON H, YOUNGS D, BENTLY S, GEORGE RH: Diarrhoea and pseudomembranous colitis after gastrointestinal operations. A prospective study. *Lancet* 1978; 2: 1165–7

3. COPPA GF, ENG K, GOUGE TH, RANSON JH, LOCALIO SA: Parenteral and oral antibiotics in elective colon and rectal surgery. A prospective, randomized trial. *Am J Surg* 1983; 145: 62–5

4. SHAPIRO M, MUÑOZ A, TAGER IB, SCHOENBAUM SC, POLK BF: Risk factors for infection at the operative site after abdominal or vaginal hysterectomy. *N Engl J Med* 1982; 307: 1661–6

5. TEASLEY DG, GERDING DN, OLSON MM, PETERSON LR, GEBHARD RL, SCHWARTZ MJ, LEE JT JR: Prospective randomized trial of metronidazole versus vancomycin for *Clostridium-difficile*-associated diarrhea and colitis. *Lancet* 1983; 2: 1043–6

6. DION YM, RICHARDS GK, PRENTIS JJ, HINCHEY EJ: The influence of oral versus parenteral preoperative metronidazole on sepsis following colon surgery. *Ann Surg* 1980; 192: 221–6

7. DZINK J, BARTLETT JG: In vitro susceptibility of *Clostridium difficile* isolates from patients with antibiotic-associated diarrhea or colitis. *Antimicrob Agents Chemother* 1980; 17: 695–8

8. SAGINUR R, HAWLEY CR, BARTLETT JG: Colitis associated with metronidazole therapy. *J Infect Dis* 1980; 141: 772–4

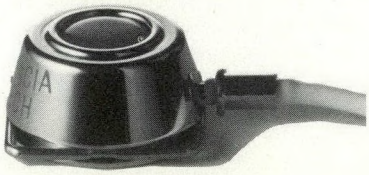
"IT HAS REALLY IMPROVED MY LIFE"

In many patients, there is usually need for repeated access to body compartments for drug delivery or fluid collection.

Port-A-Cath is a totally implantable drug delivery system, specifically designed for safe and easy repeated access.

Since the Port-A-Cath is implanted under the skin, it reduces the risk of infectious complications, spares the peripheral vasculature, allows targeted drug infusion, facilitates ambulatory treatment and does not interfere with the normal daily acitivities of the patient.

Port-A-Cath™. With the patient in mind.



Pharmacia (Canada) Inc., 2044 St. Regis Blvd., Dorval, Quebec

Pharmacia

C. DEL CAMPO, MD, FRCSC

Simplified Insertion of the Port-A-Cath Implantable Drug-Delivery System

The increasing frequency with which antineoplastic drugs are being used demands improved vascular access for their administration. Venous access through implantable catheters facilitates treatment when veins are no longer available. Totally implantable catheters of the Port-A-Cath type are preferred because they give better performance and cosmetic results, and are more convenient for the patients.

The flexibility of these catheters makes their introduction difficult. The author describes a simplified technique, using a commercially available introducer that has been used satisfactorily in thousands of pacemaker implantations. The author has used this technique routinely with a 50% decrease in operative and fluoroscopy time and without complications.

L'usage de plus en plus fréquent des médicaments antinéoplasiques exige de meilleures voies d'administration vasculaire. Quand les veines sont devenues inutilisables, l'établissement d'un accès veineux grâce à un cathéter à demeure facilite le traitement. On préfère les cathéters totalement implantables de type Port-A-Cath car ils offrent un meilleur rendement, donnent des résultats cosmétiques supérieures et sont plus commodes pour le patient.

La flexibilité de ces cathéters en rend la pose difficile. L'auteur décrit une technique simplifiée utilisant un instrument d'insertion du commerce qui a déjà été employé avec satisfaction des milliers de fois pour l'implantation de stimulateurs cardiaques. En utilisation de routine, l'auteur a obtenu par cette technique une diminution de 50% du temps d'opération et de fluoroscopie, et ceci sans complications.

From the Division of Cardiovascular and Thoracic Surgery, Halifax Infirmary, Dalhousie University, Halifax, NS

Accepted for publication Mar. 4, 1985

Reprint requests to: Dr. C. Del Campo, Rm. 413, Gerard Hall, 5303 Morris St., Halifax, NS B3J 1B6

Advances in the development of new and more effective antineoplastic drugs have made possible the control and cure of several malignant neoplasms. Most of these agents require intravenous administration. Drug combinations and multiple injections over a long period are usually necessary. Many of these drugs induce local changes in the venous wall characterized by inflammation followed by thrombosis and ultimately sclerosis. Soon venous access becomes a major problem. Pain, frustration, anxiety and expenditure of time increase with every treatment and may result in incomplete treatment or termination of therapy.

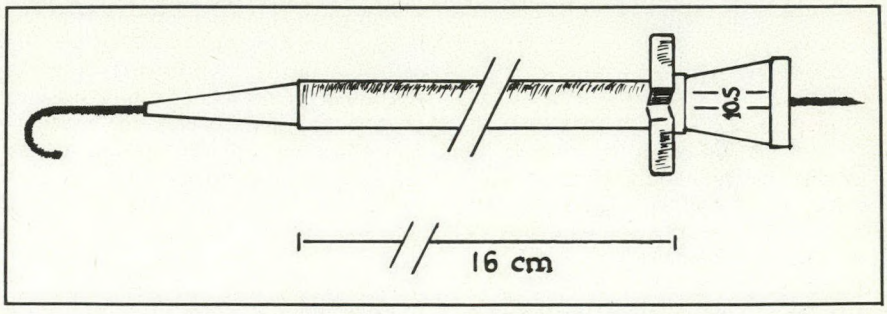


FIG. 1—J guide wire, introducer and sheath assembled after introducer and sheath have been inserted into subclavian vein. Note that J wire is positioned with J portion forward for easy cannulation without vein damage or perforation.

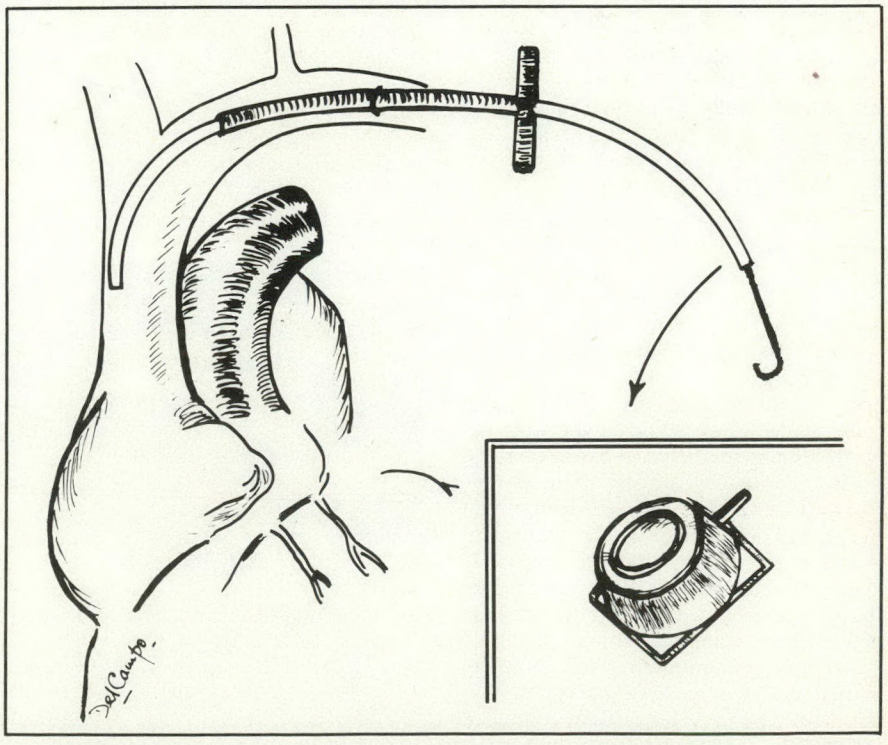


FIG. 2—Silicone catheter in position before cannula is removed. Notice that J wire inside silicone catheter is inserted in reverse fashion. Wire does not protrude past silicone catheter to avoid vein injury. Insert shows portal before connection.

Over the years some ingenious procedures have been designed in an attempt to solve this problem. Arteriovenous fistulas, vascular grafts and a variety of "permanent" intravenous catheters are commonly used.

A totally implantable drug-delivery system (Port-A-Cath, Pharmacia [Canada] Inc., Dorval, PQ) has recently been introduced. It allows blood sampling and bolus injections or continuous infusions of drugs. The device is composed of a stainless steel portal with a silicone catheter that self-seals by means of a stainless steel lock. The catheter is introduced usually through the cephalic vein and positioned under fluoroscopic control in a large central vein, most commonly the superior vena cava. The catheter is then connected to the portal.

Because the flexibility of the catheter and, in many cases, the unsuitability of the cephalic vein make this procedure difficult, I present a simplified technique for inserting the catheter.

Technique

Under sterile conditions in the operating room and using local anesthesia, a 1-cm incision is made 2 cm below the angulation of the left clavicle, in the same location that normally would be selected for a direct subclavian vein puncture. A Littleford-Spector introducer (Cordis Corp., Miami, Fla.) has all the necessary items for this. First, the subclavian vein is punctured through the incision using the syringe and 18-gauge needle provided. Blood is aspirated and then the steel J guide wire is introduced and its position checked by fluoroscopy. The needle is removed and the vessel dilator and sheath introducer are slid into place (Fig. 1). The J wire is removed. A no. 10.5 French cannula should be used because it matches the portal silicone catheter best. The J guide wire is then introduced inside the catheter to prevent it from coiling and to speed its insertion into the superior vena cava. The J guide wire is best introduced backwards, leaving the "J" part outside because this way it slides better into the portal catheter. It should be lubricated with heparinized saline solution. The guide wire is advanced no further than the tip of silicone catheter to avoid damage to the venous wall during its insertion. The catheter is then inserted through the sheath and positioned (Fig. 2). The sheath is removed. A nonabsorbable suture is used to fix the catheter. The J guide wire should not be removed until the suture is tied to prevent inadvertent occlusion or narrowing of the lumen. This complete maneuver usually takes less than 5 minutes. The catheter is then tunnelled subcutaneously to the area of the permanent pocket and connected to the portal as described by the manufacturer.

Discussion

The Littleford–Spector introducer was originally manufactured for the rapid insertion of permanent endocardial electrodes for cardiac pacing.[1] The technique is widely used. It is the alternative procedure of choice for me when the cephalic vein is unsuitable for cannulation during pacemaker insertion. I have not experienced any complications with this technique in over 300 pacemaker insertions.

The original technique has been adapted and modified to facilitate the insertion of the silicone catheter of the portal delivery system. The silicone catheter is softer and more flexible than a pacemaker lead. Thus, it may coil inside the large central veins. Because of its flexibility, it is also difficult to manipulate into position. Use of the J guide wire to stent the silicone catheter has several advantages: it provides temporary support for catheter insertion and manipulation, increases the visibility of the catheter during fluoroscopy, reduces fluoroscopic time to a minimum because of easier manipulation and the predetermined location of the introducing cannula and prevents inadvertent occlusion or narrowing of the silicone catheter by the securing suture. When the no. 10.5 French introducer is used, the inner diameter of the cannula matches perfectly the outer diameter of the silicone catheter. Thus, insertion is easy and blood loss is almost nil. This has been my procedure of choice for all my recent insertions. There have been no complications and time taken for insertion has been reduced by more than 50%.

Reference

1. LITTLEFORD PO, SPECTOR SD: Device for the rapid insertion of a permanent endocardial pacing electrode through the subclavian vein: preliminary report. *Ann Thorac Surg* 1979; 27: 265-9

TIMOTHY L. WINTON, B SC, M SC, MD;* MURRAY J. GIROTTI, B SC, MD, FRCSC;*
PAUL N. MANLEY, MD, FRCPC;† ERNEST E. STERNS, MD, FRCSC, FACS*

Delayed Intestinal Perforation After Nonpenetrating Abdominal Trauma

The incidence of hollow-organ injury has increased steadily since the use of seat-belts was introduced. It has become apparent that the clinical manifestations of intestinal injury may be delayed considerably. Delayed perforations can pose a diagnostic challenge to the attending surgeon. The authors report four patients who suffered delayed intestinal perforation 6 or more days after sustaining nonpenetrating abdominal trauma in motor vehicle accidents while wearing passive seat-belt restraints. All patients had low severity of injury (scores ranging from 4 to 13) but had persistent vague abdominal pain before perforation occurred. Three of the four patients suffered spinal trauma as their major initial injury. Such patients appear to be at higher risk for delayed perforation and should be monitored carefully.

La fréquence des blessures des organes creux augmente régulièrement depuis l'avènement de la ceinture de sécurité. Il est devenu évident que les manifestations cliniques des blessures intestinales peuvent être considérablement retardées. Les perforations retardées peuvent constituer pour le chirurgien traitant un défi de diagnostic important. Les auteurs décrivent quatre patients qui ont souffert d'une perforation intestinale retardée, 6 jours ou plus après avoir subi une contusion abdominale au cours d'un accident de la route, alors qu'ils portaient une ceinture de sécurité. Tous les patients avaient subi des blessures de peu de gravité (cotes variant de 4 à 13) mais souffraient de douleur abdominale vague persistante avant que la perforation ne survienne. Trois des quatres patients avaient subi un traumatisme spinal comme blessure initiale majeure. Ces patients semblent présenter un risque plus élevé de perforation retardée et devraient faire l'objet d'une surveillance attentive.

*From the *Department of Surgery and †Department of Pathology, Queen's University, Kingston General Hospital, Kingston, Ont.*

Accepted for publication Apr. 9, 1985

Reprint requests to: Dr. M.J. Girotti, Eaton Building North 9-234, Toronto General Hospital, 200 Elizabeth St., Toronto, Ont. M5G 2C4

The incidence of intestinal injury secondary to nonpenetrating abdominal trauma has increased markedly in North America in conjunction with the use of seat-belt restraints in motor vehicles.[1] Injury to hollow organs is difficult to diagnose even when there is perforation as it is not usually associated with major blood or volume loss. Furthermore, specific physical findings and definitive diagnostic, laboratory and radiologic investigations are lacking. Intestinal injury is usually discovered during exploratory laparotomy for a hemoperitoneum uncovered during peritoneal lavage or for injury to other abdominal or retroperitoneal viscera. The present trend towards nonoperative management of hemoperitoneum in an effort to preserve splenic function will make such discoveries less frequent.[2-4]

Delayed intestinal perforation is a potentially lethal complication of blunt abdominal trauma. The surgical literature contains only isolated case reports or anecdotal mention of this phenomenon.[5-7] We report four such cases of delayed intestinal perforation managed at this institution over the past 24 months. We discuss the diagnostic difficulties and concepts of pathophysiology and make recommendations for the management of patients with this complication.

Case Presentations

Table I documents the salient features of the four patients with delayed posttraumatic intestinal perforation referred to the Kingston General Hospital for management. All were males who were involved in motor vehicle accidents. All wore seat-belts, three of the lap type and one a three-point shoulder type.

The four patients demonstrated the following findings in common. The clinical manifestations on original admission suggested a modest insult but there was no serious hypotension (injury severity scores 4, 10, 10 and 13[8]). The abdominal findings were nonspecific. All had persistent abdominal complaints but no localized or generalized abnormalities could be found despite repeated physical examinations. There was a substantial interval between the time of admission and the diagnosis of perforation (6 to 36 days). None of the laboratory or radiologic studies, performed initially or during the period before operation, were diagnostic. The patients had resumed oral intake and had normal bowel movements before the full evolution of their intestinal perforation. Acute peritoneal signs eventually developed on physical examination and at operation localized perforation of small or large bowel was found.

In three patients there was evidence of an adjacent mesenteric hematoma and three had an associated spinal injury. After definitive treatment, these patients are alive and well and intestinal continuity has been re-established in the two patients who had a colostomy. Examination of the resected intestinal segments (Fig. 1) showed transmural ischemic necrosis of either small or large bowel in all four patients.

Discussion

In North America, motor vehicle accidents remain the commonest cause of blunt abdominal trauma.[1,6] Before the use of seat-belts became widespread, intestinal injury as a result of blunt trauma was most often reported as an incidental finding during laparotomy for hemoperitoneum due to splenic and hepatic injuries.[9-13] At most, 25% of laparotomies for blunt abdominal trauma have an intestinal component. Usually, this is either a serosal or mesenteric hematoma, with less than 5% of the injuries requiring small- or large-bowel resection.[14] The incidence of injury to hollow organs has risen concomitantly with the increased use of seat-belts. In a single series, Denis and associates[5] reported that over 80% of their patients sustained serious intestinal injury in motor vehicle accidents while wearing selt-belts. Within this group, 17 of 27 patients had a spontaneous perforation while 5 more had evidence of intestinal ischemia without necrosis. When a patient suffers injury to the lumbar spine in a motor vehicle accident while wearing a seat-belt, an intestinal injury should be suspected even in the initial absence of abdominal findings. Several reports have documented a significant correlation between these injuries.[5,7] The clinical diagnosis of peritoni-

tis in association with spinal trauma can be very difficult. Physical findings may be misleading because of local abdominal wall trauma or neurologic deficits related to the spinal injury. Moreover, prolonged ileus is a well-known sequela of spinal fractures in the absence of neurologic deficits.

The early and late diagnosis of posttraumatic intestinal injury is difficult. Minilaparotomy (peritoneal lavage) as recommended by the Committee on Trauma of the American College of Surgeons, will aid in the diagnosis of immediate intestinal perforation should Gram's staining of the abdominal effluent identify organisms.[5,15] Peritoneal lavage that contains no organisms or blood or one that contains 50 to 100 $\times$ 10^9/L erythrocytes, which is often found with a mesenteric hematoma, is of no help.

There has been a definite move to nonoperative management of patients with a positive peritoneal lavage who are hemodynamically stable and have low injury severity scores.[2-4,16-18] This has been based on the observation that splenic or hepatic injuries, the commonest causes of positive peritoneal lavage, are often not actively bleeding at the time of laparotomy. The development of sophisticated imaging techniques has aided diagnosis of intra-abdominal traumatic injury and has spared many individuals (mostly children) an unnecessary laparotomy and splenectomy with the possibility of postsplenectomy sepsis.[19,20]

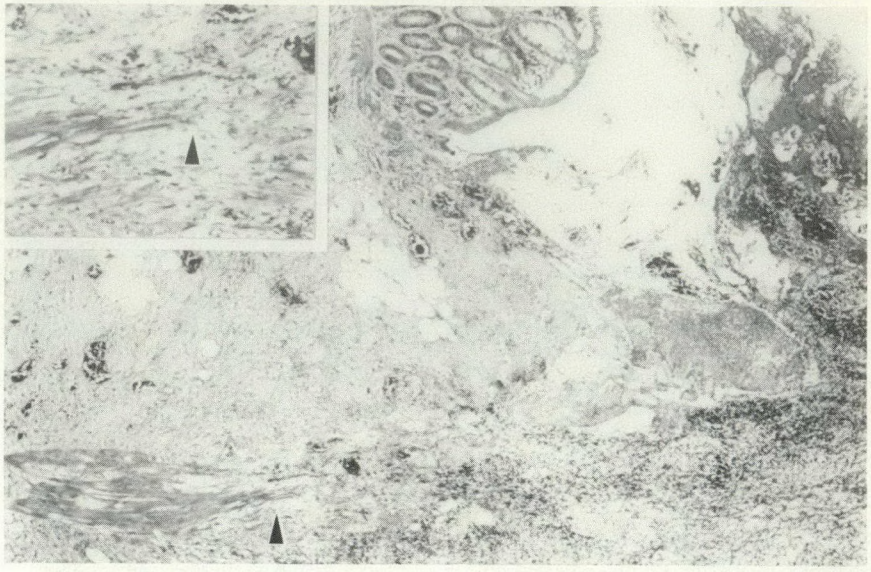


FIG. 1—Photomicrograph adjacent to site of perforation. There is hemorrhage and very recent necrosis of muscularis propria (arrow). Inset: necrosis of this muscle (arrow) is associated with neutrophilic infiltrate, suggesting recent ischemic necrosis. (Hematoxylin-phloxine-safranine $\times$ 120; inset $\times$ 300.)

Table I—Clinical Summary of Patients With Delayed Intestinal Perforation After Trauma

Age, yr	Sex	Hypotension	Abdominal findings	Peritoneal lavage	Associated injury	Injury severity score[8]	Radiologic findings	Course	Laparotomy findings	Surgical management
7	M	No	Abdominal wall contusion. Diffuse tenderness	No	Fracture dislocation L3–4	10	Absent psoas right side. Retroperitoneal signs on computerized tomogram	Persistent mild abdominal pain. Sudden onset peritoneal signs on day 6	Perforation mid-jejunum. Mesenteric hematoma. Seromuscular tears proximal and distal to perforation	Resection with primary anastomosis
29	M	Yes (crystalloid only)	Diffuse tenderness only	No	Fracture pubic rami and L3	13	3 views of abdomen all normal	Day 6 — acute onset of peritoneal signs, hypotension, free intra-peritoneal air	Perforated jejunum 12 cm distal to ligament of Treitz. Ischemic sigmoid colon with mesenteric hematoma	Jejunal resection, primary anastomosis, sigmoid resection, end-colostomy and mucous fistula
47	M	No	Abdominal wall contusion. Diffuse tenderness	Yes, negative	Compression fracture L3 and L4	10	Plain films normal	Persistent abdominal pain. Day 36 — large bowel obstruction with flow of barium into abscess cavity	Perforated fibrotic stricture of mid-sigmoid, communicating with abscess cavity	Hartmann procedure, drainage of abscess
41	M	No	Abdominal wall hematoma	Yes, positive (100 X 10^9/L erythrocytes)	None	4	3 views of abdomen all normal. Computerized tomogram normal	Persistent mild abdominal pain. Discharged on day 7. Returned 12 h later with acute onset rigid abdomen	Free perforation mid-transverse colon; mesenteric hematoma	Colonic resection with double-barrelled colostomy

Unfortunately, there are no reliable symptoms or signs to lead to a definitive diagnosis of hollow-organ injury.[7,11-13] As in previous series,[21] abdominal pain of variable severity and initially without notable physical findings was the only consistent feature. Abdominal guarding, rebound tenderness and auscultation of bowel sounds are notoriously unreliable. In fact, tolerance of oral intake and return of bowel function occurred in all our patients despite serious underlying intestinal injury.

Similarly, there are no specific laboratory investigations that lead to a definitive diagnosis of intestinal injury. Plain films of the abdomen are unreliable.[19] Evidence of free intraperitoneal air is seen in less than 50% of patients with intestinal perforation.[19] Although abdominal computerized axial tomography is effective in diagnosing disruption of solid organs, it is less reliable in detecting hollow-organ injury.[19,20] Water-soluble contrast studies have been used to rule out proximal small-bowel injury or disruption. In patients who sustain vascular damage to the mesentery, resulting in eventual ischemic necrosis, early radiologic signs may be difficult if not impossible to detect.

Laparoscopy under general or local anesthesia has been used in the emergency room to replace peritoneal lavage and allow complete examination of the peritoneal cavity.[22] This modality could identify patients with potential intestinal injuries that might lead to perforation. Carefully staged, progressive resumption of oral intake should be undertaken with this possibility in mind. However, it must be remembered that even with laparoscopy, serious trauma might be missed. Repeat minilaparotomy may be useful in this period as Gram's staining of the effluent is more likely to identify a mixture of intestinal organisms.

The pathological findings of the resected intestinal segments in one of our patients lead us to agree with Bolton and colleagues[9] that delayed post-traumatic perforation of the intestine occurs as a result of ischemia either through direct trauma to the intestinal wall or indirectly by trauma to the mesenteric vessels. Robbs and colleagues[12] have suggested that this process can evolve within 24 to 48 hours of the initial injury. Presumably, the most common mechanism of injury to the intestine or adjacent mesentery is due to the lap belt, properly placed or otherwise, which compresses these structures against the fixed spinal column during rapid deceleration of the motor vehicle. This would account for the associated spinal fractures seen in this series as well as others.[4,7,11-13] These authors subsequently treated another patient who suffered localized peritonitis 24 hours after blunt abdominal trauma. A segment of devascularized necrotic jejunum was found which undoubtedly would have resulted in perforation.

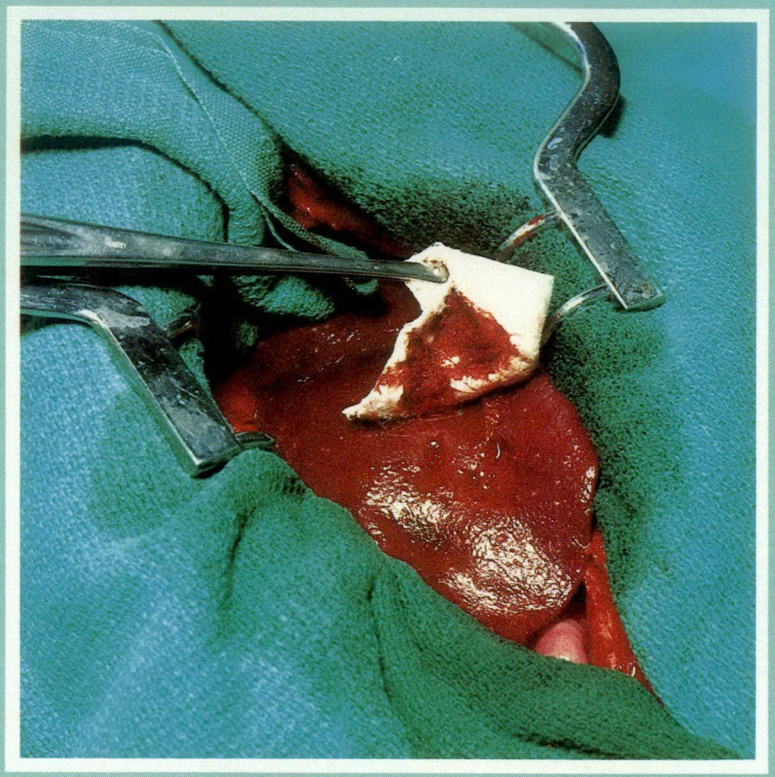
Following blunt abdominal trauma caused by the seat-belt in a motor vehicle accident, the persistence of abdominal pain during the first week should alert the attending surgeon that an undiagnosed intestinal injury may exist. Associated spinal or pelvic fractures should heighten the suspicion. The use of water-soluble radiologic studies to outline the colon or small bowel should be considered. Repeat minilaparotomy or laparoscopy should also be considered if the radiologic findings are inconclusive. It is obvious that the development of peritonitis is an indication for immediate laparotomy.

References

1. COX EF: Blunt abdominal trauma. A 5-year analysis of 870 patients requiring celiotomy. *Ann Surg* 1984; 199: 467–74
2. JOSEPH TP, WYLLIE GG, SAVAGE JP: The non-operative management of splenic trauma. *Aust NZ J Surg* 1977; 47: 179–82
3. KING DR, LOBE TE, HAASE GM, BOLES ET JR: Selective management of injured spleen. *Surgery* 1981; 90: 677–82
4. LUTZKER LG, CHUN KJ: Radionuclide imaging in the nonsurgical treatment of liver and spleen trauma. *J Trauma* 1981; 21: 382–7
5. DENIS R, ALLARD M, ATLAS H, FARKOUH E: Changing trends with abdominal injury in seatbelt wearers. *J Trauma* 1983; 23: 1007–8
6. GUMMER JWP, RANKLING GN: Delayed traumatic rupture of intestine. *Br J Med* 1953; 2: 82–3
7. SCHENK WG III, LONCHYNA V, MOYLAN JA: Perforation of the jejunum from blunt abdominal trauma. *J Trauma* 1983; 23: 54–6
8. Committee on Injury Scaling: *The Abbreviated Injury Scale*, American Association for Automotive Medicine, Morton Grove, Ill., 1980
9. BOLTON PM, WOOD CB, QUARTEY-PAPFIO JB, BLUMGART HL: Blunt abdominal injury: a review of 59 consecutive cases undergoing surgery. *Br J Surg* 1973; 60: 657–63
10. MEYER AA, CRASS RA: Abdominal trauma. *Surg Clin North Am* 1982; 62: 105–11
11. RAZALI H, THOMAS WMC: Isolated jejunal injuries arising from blunt abdominal trauma. *Injury* 1974; 6: 33–5
12. ROBBS JV, MOORE SW, PILLAY SP: Blunt abdominal trauma with jejunal injury: a review. *J Trauma* 1980; 20: 308–11
13. SINCLAIR MC, MOORE TC, ASCH MJ, BROSMAN SA: Injury to hollow abdominal viscera from blunt abdominal trauma in children and adolescents. *Am J Surg* 1974; 128: 693–8
14. ZUCKER K, BROWNS K, ROSSMAN D, HEMINGWAY D, SAIK R: Nonoperative management of splenic trauma. Conservative or radical treatment? *Arch Surg* 1984; 199: 400–4
15. BIVINS BA, SACHATELLO CR, DAUGHERTY ME, ERNST CB, GRIFFEN WO JR: Diagnostic peritoneal lavage is superior to clinical evaluation in blunt abdominal trauma. *Am Surg* 1978; 44: 637–41
16. DOUGLAS GJ, SIMPSON JS: The conservative management of splenic trauma. *J Pediatr Surg* 1971; 6: 565–70
17. HEBELER RF, WARD RE, MILLER PW, BEN-MENACHEM Y: The management of splenic injury. *J Trauma* 1982; 22: 492–5
18. MORGENSTERN L, UYEDA RY: Nonoperative management of injuries of the spleen in adults. *Surg Gynecol Obstet* 1983; 157: 513–8
19. FEDERLE MP, GOLDBERG HI, KAZER JA, MOSS AA, JEFFREY RB JR, MALL JC: Evaluation of abdominal trauma by computed tomography. *Radiology* 1981; 138: 637–44
20. PIEKARSKI J, FEDERLE MP, MOSS AA, LONDON SS: Computed tomography of the spleen. *Radiology* 1980; 135: 683–9
21. DUPRIEST RW JR, RODRIGUEZ A, KHANEJA SC, SODERSTROM CA, MAEKAWA KA, AYELLA RJ, COWLEY RA: Open diagnostic peritoneal lavage in blunt trauma victims. *Surg Gynecol Obstet* 1979; 148: 890–4
22. BERCI G, DUNKLEMAN D, MICHEL S, SANDERS G, WAHLSTROM E, MORGENSTERN L: Emergency minilaparoscopy in abdominal trauma. An update. *Am J Surg* 1983; 146: 261–5

mallitene®

Microfibrillar Collagen Hemostat



Photograph courtesy of the
University of Alberta,
Surgical Medical Research Institute
Special thanks to Dr. Garth Warnock

In cases where surgical techniques are ineffective in controlling bleeding, surgeons are switching to Mallitene because of its remarkable easy-to-handle form and extremely fast hemostatic action.

MALLITENE
is available in the following sizes:

Size	Weight	Pieces/Pack	Order #
5 x 8 cm	1000 mg.	10	11158
3 x 5 cm	375 mg.	10	11135

Detailed information available on request.

If you would like to try Mallitene, please write us:

malliner laboratories
10548 - 82 Avenue, Edmonton, Alberta T6E 2A4
or CALL US COLLECT
(403) 433-8466

Malliner Laboratories Inc. is a Canadian company wholly owned by Canadians.

JAMES RUTKA, MD; PAUL J. MULLER, MD, M SC, FRCSC; MARIO CHUI, MD, FRCPC

Preoperative Gelfoam Embolization of Supratentorial Meningiomas

Intracranial meningiomas are often highly vascular and a successful outcome depends upon surgical resection. Preoperative embolization of supratentorial meningiomas, which have a major blood supply from the external carotid artery, has been advocated to reduce intraoperative bleeding and thus facilitate surgical extirpation. The authors carried out transfemoral, Gelfoam embolization preoperatively in eight patients with supratentorial meningiomas. In seven of the cases, post-embolization, contrast-enhanced, computerized tomography was carried out. Areas of low-density tumour necrosis were identified in five. In three of the eight patients, post-embolization angiography demonstrated elimination of the tumour blush and in the other five, the blush was reduced in intensity. Histologic evidence of tumour embolization was identified in each case to a varying degree.

Preoperative embolization resulted in an identifiable radiologic change in the majority of these tumours, but the authors could not determine, in this small series, whether intraoperative bleeding was reduced.

Les méningiomes intracrâniens sont souvent très vascularisés et la guérison dépend souvent de la résection chirurgicale. Une embolisation préopératoire des méningiomes supratentoriaux qui possèdent une circulation sanguine importante provenant de l'artère carotide externe, a été recommandée pour réduire l'hémorragie opératoire et, ainsi, faciliter l'extirpation chirurgicale. Les auteurs ont pratiqué en préopératoire une embolisation transfémorale au Gelfoam chez huit patients porteurs de méningiomes supratentoriaux. Après l'embolisation, on a effectué, dans sept de ces cas, une tomographie transverse axiale sur ordinateur avec augmentation du contraste. Des régions de nécrose tumorale à faible densité ont été identifiées chez cinq patients. Chez trois des huits patients, l'angiographie post-embolisation a révélé l'élimination de l'ombre tumorale et dans les cinq autres cas l'intensité en était réduite. Des signes histologiques d'embolisation tumorale ont été identifiés à des degrés divers dans tous les cas.

L'embolisation préopératoire a entraîné des changements radiologiques identifiables pour la majorité des tumeurs mais, a cause du petit nombre de sujets dans cette étude, il n'a pas été possible pour les auteurs de déterminer si elle avait réduit les saignements durant l'intervention chirurgicale.

From the Department of Surgery, Division of Neurosurgery and Department of Radiology, Division of Neuroradiology, St. Michael's Hospital, and University of Toronto, Toronto, Ont.

Accepted for publication May 21, 1985

Reprint requests to: Dr. P.J. Muller, Head, Division of Neurosurgery, St. Michael's Hospital Annex, 38 Shuter St., Toronto, Ont. M5B 1A6

Meningiomas account for approximately 14% of all intracranial tumours.[1] They are usually histologically benign and the subsequent outcome depends on the success of surgical resection.[2] This may be compromised by the highly vascular nature of many of these tumours. Meningiomas arise from arachnoid cap cells, are usually attached to dura and often receive their main blood supply from the external carotid artery. Embolization of the vessels supplying the tumour may reduce intraoperative bleeding and make total surgical resection more likely. The preoperative embolization of the external carotid feeding vessels was introduced by Manelfe and associates in 1973[3] and has been advocated by others.[4,5] Both superselective angiography and embolization of appropriate external carotid branches[4] and subselective embolization of the terminal external carotid artery proximal to the maxillary artery[5] have been used.

We report herein the results of preoperative transfemoral embolization in eight patients with supratentorial meningiomas.

Methods and Findings

Patient Selection

Patients with computerized tomograms compatible with a supratentorial meningioma were selected for angiographic assessment and possible embolization. Informed consent was first obtained from the patient. Embolization was carried out at the time of initial angiography if the angiogram confirmed the diagnosis of meningioma and demonstrated that the external carotid artery formed the main blood supply to the tumour. The procedure was carried out under local anesthesia.

Patients

The eight patients ranged in age from 28 to 66 years. There were two men and six women. The tumours were located at the lateral sphenoid wing in two cases, the frontoparietal convexity in five and arose from the temporal fossa floor and occupied the temporoparietal convexity in one case. Maximum tumour diameters, as determined from the computerized tomograms, ranged from 4.8 to 8.3 cm. The ages, sex, clinical presentation, tumour location and histologic type are summarized in Table I.

Embolization

The transfemoral route was used to obtain selective internal and external carotid angiograms in each case. Superselective catheterization of feeding vessels from the external carotid artery was attempted and embolization was carried out using Gelfoam powder. Angiography was performed immediately after embolization using the same contrast volume and injection sequence as before. No serious complications occurred; one patient had ipsilateral facial pain but it resolved spontaneously within 12 hours.

Computerized Tomography

Contrast-enhanced computerized tomograms were acquired before embolization in each case. In seven patients the appearance was of a homogeneous, hyperdense tumour. In five of seven scans obtained after embolization, there were areas of low density in the previously homogeneously high-density tumours

(Table II) and they were interpreted as areas of ischemic necrosis (Figs. 1 and 2). In no case was the contrast enhancement totally obliterated.

Angiography

All patients had a demonstrable tumour blush on the pre-embolization angiogram. Table II summarizes the tumour blood supply, the vessels embolized and the angiographic results of embolization. In three patients the tumour blush was completely eliminated (Figs. 3 and 4). In four it was markedly reduced. In one patient the tumour blush, although reduced, was still moderately intense.

Surgical and Pathological Findings

Total surgical resection of the meningiomas was achieved in all cases. All but one patient was operated on within 4 days of embolization; in that case, surgery was delayed 5 months for medical reasons unrelated to the tumour or to the embolization procedure. It is of interest that sequential computerized tomograms on this patient revealed a reduction in tumour size but a return of the homogeneous hyperdensity (Figs. 5 and 6).

Histologic assessment of the surgical specimens revealed Gelfoam emboli and areas of necrosis in six of the seven patients operated on early after embolization (Table III). The histologic assessment of the patient whose operation was delayed revealed blood-vessel hyalinization and ischemic fibrosis within the tumour.

Five patients required blood transfusion. An estimate of the intraoperative blood loss was made by adding the number of units of blood transfused and the postoperative fall in the hemoglobin level (measured in grams per decilitre). A linear relation between the estimated blood loss and the maximum tumour diameter was evident, but in this small series no correlation between blood-loss estimate and post-embolization blush could be identified.

Discussion

Adegbite and associates[2] in their review of 114 surgically treated meningiomas found that the degree of surgical resection was the only important factor influencing recurrence. It might be assumed that reducing tumour vascularity and thus intraoperative bleeding might facilitate the total removal of these tumours.

Intracranial meningiomas arise from arachnoid cap cells and, with few exceptions, have a dural attachment. In the majority, the main blood supply is from the external carotid artery; however, branches of the internal carotid are often a major source of additional blood supply. It has been shown that the capsule of the tumour tends to have an internal carotid supply and the stalk of the tumour and much of the interior has an external carotid supply.[6] The proportion of inter-

FIG. 1—Case 2. Pre-embolization, contrast-enhanced, computerized tomogram showing large, homogeneously hyperdense meningioma located in left frontoparietal convexity.

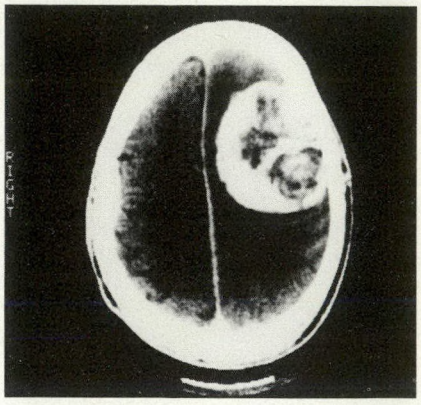


FIG. 2—Case 2. Post-embolization tomogram shows large areas of low density within meningioma.

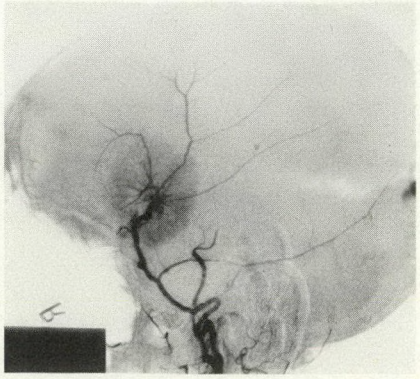


FIG. 3—Case 3. Pre-embolization angiogram showing tumour blush of lateral sphenoid-wing meningioma.

Table I—Patient Data

Case no.	Age, yr	Sex	Presentation	Tumour location	Histologic type
1	36	F	Loss of vision, headache	Right frontal convexity	Transitional
2	66	M	Dysphasia, hemiparesis	Left frontoparietal convexity	Transitional
3	27	M	Seizure	Right lateral sphenoid wing	Transitional
4	34	F	Headache	Right frontoparietal convexity	Syncical
5	57	F	Dysphasia	Left temporal lobe	Transitional
6	33	F	Seizure, dysphasia	Left frontal convexity	Transitional
7	77	F	Seizure	Right frontal convexity	Transitional
8	60	F	Memory loss	Left lateral sphenoid wing	Transitional

Table II—Details of Computerized Tomography, Blood Supply to Tumour and Embolization

Patient no.	Post-embolization low-density changes	Interval from embolization to tomography, h	Tumour blood supply					Vessels embolized	Post-embolization tumour blush
			MCA	OPH	MMA	STA	OCC		
1	Yes	12	+	–	+	+	–	Distal ECA	Reduced 50%
2	Yes	12	+	+	+	+	–	MMA, STA	Eliminated
3	Yes	48	–	–	+	–	–	INT MAX	Eliminated
4	Slight	48	–	–	+	–	–	MMA	Reduced 50%
5	Not done	–	–	–	+	–	+	INT MAX	Reduced 25%
6	Yes	24	–	–	+	–	–	MMA	Eliminated
7	No change	24	–	+	+	–	–	INT MAX	Reduced 50%
8	No change	24	–	–	+	–	–	MMA	Reduced 75%

MCA = middle cerebral artery, OPH = ophthalmic artery, MMA = middle meningeal artery, STA = superficial temporal artery, OCC = occipital artery, ECA = external carotid artery, INT MAX = internal maxillary artery.

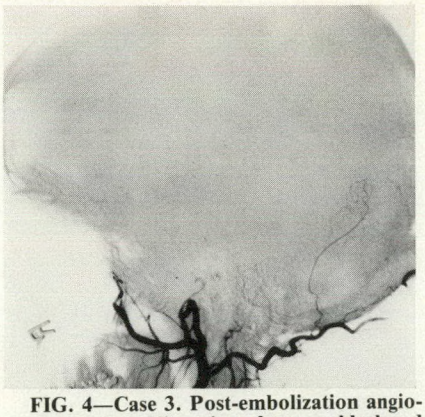


FIG. 4—Case 3. Post-embolization angiogram showing obliteration of tumour blush and occlusion of distal external carotid branches.

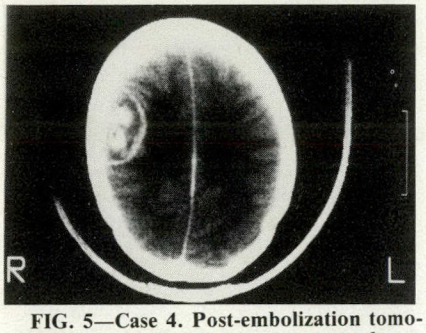


FIG. 5—Case 4. Post-embolization tomogram shows low-density tumour core and margin of contrast enhancement.

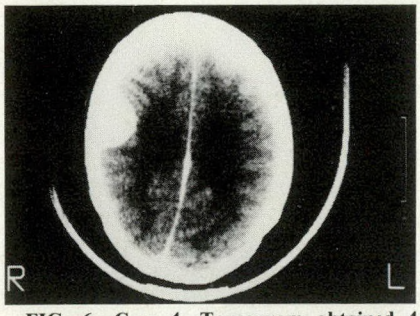


FIG. 6—Case 4. Tomogram obtained 4 months after embolization showing return of homogeneous hyperdensity and 50% reduction in tumour size.

nal carotid to external carotid supply is quite variable and unpredictable. Even when the angiographic assessment fails to show an internal carotid blood supply, there are often vessels that are too small for angiographic detection.[4] Furthermore, it has been suggested that after external carotid embolization, the internal carotid supply to the tumour increases and may partly negate the effect of embolization.[7] Nevertheless, recent reports have shown that preoperative embolization of meningiomas can result in identifiable changes in the tumour.[4,5]

Richter and Schachenmayer[4] described four methods by which the effect of preoperative embolization might be assessed: angiographic demonstration of an alteration or elimination of the tumour blush; the development of low-density areas on post-embolization computerized tomograms; the intraoperative assessment of vascularity; the histologic identification of necrosis, tumour vessel thrombosis and embolism. In their series of 31 patients with meningiomas who underwent superselective embolization preoperatively, the external carotid tumour blush was eliminated in 24. In 18, histologic evidence of ischemic or hemorrhagic necrosis was identified although the areas of necrosis were small, ranging from microscopic to 5 mm in size. These authors concluded that preoperative embolization was a useful adjunct to surgical resection of meningiomas, especially when the tumour blood supply was primarily derived from the external carotid artery.

In 23 of 27 patients with intracranial meningiomas on whom Teasdale and colleagues[5] performed subselective external carotid embolization, post-embolization angiograms showed elimination of the external carotid blush. In 8 of 17 patients who underwent post-embolization computerized tomography, low-density areas were identified. Histologically, 10 of 26 specimens contained embolic material and 14 showed evidence of necrosis.

Baum and colleagues[8] assessed the difference in radionuclide scans from two patients with meningiomas before and after Gelfoam embolization of the external carotid feeding vessels; in both cases the tumours were no longer visualized in the arterial phase but were present in the venous phase. Teasdale's group[5] used radioisotope imaging to estimate tumour blood flow and volume and found no correlation between the vascularity demonstrated angiographically and the assessment of blood flow and volume. In patients for whom post-embolization isotope scans were obtained, no gross changes were identified overall; in three with pure external carotid feeding vessels, some reduction in flow was noted; in some with both internal and external carotid supply, flow and volume increased. This observation tends to substantiate the view of Djindjian and Merland[7] that internal carotid feeding vessels multiply after the obliteration of external carotid feeders.

Conclusions

The use of embolization of meningiomas preoperatively results in identifiable computerized tomographic and angiographic changes in the meningioma and may reduce intraoperative bleeding from external carotid artery feeding vessels; however, the overall reduction in vascularity depends on the relative contributions of the internal and external feeders. Because of the small numbers, we could not speculate as to the efficacy of reducing tumour blood loss during surgery.

We thank Drs. Wm. Horsey, Wm. Tucker and A. Hudson for allowing us to include their patients; and Miss Dena Evans for secretarial assistance.

Table III—Details of Tumour Vascularity, Blood Status and Histologic Findings

Patient no.	Tumour diameter, cm	Surgeons' description of intraoperative vascularity	Blood			Histologic findings
			Units transfused	Hemoglobin change, g/dL	Total loss, units	
1	5.6	Moderate	6	1.8	7.8	Gelfoam emboli, areas of necrosis
2	7.2	High	4	4.8	8.8	Gelfoam emboli
3	4.2	Moderate	4	3.4	7.4	Gelfoam emboli, areas of necrosis
4	4.2	Low	0	1.5	1.5	Hyalinization, ischemic fibrosis
5	7.0	Moderate	4	4.7	8.7	Gelfoam emboli, areas of necrosis
6	4.0	Low	0	2.0	2.0	Gelfoam emboli, areas of necrosis
7	4.7	Low	0	2.7	2.7	Single dural Gelfoam embolus
8	5.8	Low	2	2.2	4.2	Gelfoam emboli

References

1. RUSSEL DS, RUBINSTEIN LJ: *Pathology of Tumors of the Nervous System*, 3rd ed, Edward Arnold, London, 1971: 49
2. ADEGBITE AB, KHAN MI, PAINE KWE, TAN LK: The recurrence of intracranial meningiomas after surgical treatment. *J Neurosurg* 1983; 58: 51–6
3. MANELFE B, GUIRAUD J, DAVID J, EYMERI JC, TREMOULET J, ESPAGNO J, RASCOL A, GÉRAUD J: Embolisation par cathétérisme des méningiomes intracraniens. *Rev Neurol* 1973; 128: 339–51
4. RICHTER HP, SCHACHENMAYR W: Preoperative embolization of intracranial meningiomas. *Neurosurgery* 1983; 13: 261–8
5. TEASDALE E, PATTERSON J, MCLELLAN D, MACPHERSON P: Subselective preoperative embolization for meningiomas: a radiological and pathological assessment. *J Neurosurg* 1984; 60: 506–11
6. PELLET N: La vascularisation des méningiomes. Thesis médicale, Marseilles, 1968: 238
7. DJINDJIAN R, MERLAND JJ: *Super-Selective Arteriography of the External Carotid Artery*, Springer-Verlag, Berlin, 1978: 247–51
8. BAUM S, COLEMAN LL, LATSHAW RF, PAGE RB, WEIDNER WA: Radionuclide blood flow studies before and after Gelfoam embolization of intracranial meningiomas. *Clin Nucl Med* 1979; 4: 412–4

WAIL G. LAKKIS, MD; MARKUS C. MARTIN, MD, CM, FRCSC, FACOG;
MORRIE M. GELFAND, MD, CM, FRCSC, FACOG

Benign Cystic Teratoma of the Ovary: a 6-Year Review

Benign cystic teratoma of the ovary was diagnosed histologically in 118 patients over 6 years at the Sir Mortimer B. Davis-Jewish General Hospital in Montreal. The charts were reviewed with respect to population distribution, symptomatology, diagnostic procedures and treatment. Of the 118 patients, 85.6% were younger than 40 years. Only 3.4% had documented recurrence and 6.8% were pregnant. Roentgenograms of the pelvis revealed calcification in 64.1% of cases. Ultrasonography of the pelvis failed to make the diagnosis in 19.4%. The majority of patients had a Pfannenstiel incision (78.8%) and underwent oophorectomy (55.3%). In half the patients the contralateral ovary was only palpated.

En 6 ans, des tératomes kystiques bénins des ovaires ont été diagnostiqués histologiquement chez 118 patientes, à l'Hôpital Général Juif Sir Mortimer B. Davis de Montréal. Les dossiers médicaux de ces patientes ont été étudiés pour la distribution de la population, la symptomatologie, les interventions diagnostiques et le traitement. Des 118 patientes, 85.6% avaient moins de 40 ans. Seulement 3.4% ont montré des preuves de récidive et 6.8% étaient enceintes. La roentgenographie du bassin a démontré la calcification dans 64.1% des cas. L'échographie ultrasonique du bassin n'a pas permis de faire le diagnostic dans 19.4% des cas. La majorité des patientes ont eu une incision de Pfannenstiel (78.8%) et ont subi une ovariectomie (55.3%). Chez la moitié des patientes, l'ovaire contralatéral n'a été que palpé.

From the Department of Obstetrics and Gynecology, Sir Mortimer B. Davis-Jewish General Hospital, Montreal, PQ

Accepted for publication May 21, 1985

Reprint requests to: Dr. Markus C. Martin, Ste. 600, 5845 Côte des Neiges, Montreal, PQ H3S 1Z4

Most ovarian teratomas are benign and cystic. They are usually of ectodermal origin and consist of a large compartment, containing sebaceous material admixed with hair, and a small solid portion known as Rokitansky's protruberance. The latter, which is usually located at the base of the tumour, may consist of mature cartilage, a well-formed calcific tooth or ill-defined calcifications.[1] Hormonally active tissue may be found in benign cystic teratomas.[2] Ovarian teratomas develop from the products of the first meiotic division of a single oocyte and are routinely homozygous, containing a single late replicating X chromosome.[2]

Patients and Method

Between Jan. 1, 1978 and Dec. 31, 1983, 118 patients were discharged from the gynecology service at the Sir Mortimer B. Davis-Jewish General Hospital in Montreal with a histologic diagnosis of benign cystic teratoma of the ovary (Fig. 1). The medical records of these patients were reviewed to determine the population distribution, symptomatology and the diagnostic procedures, and type of treatment used. The series was drawn from the pathology department's computerized list of patients classified as having benign cystic teratoma of the ovary, within the specified years. The study included 123 cysts, since five patients had bilateral tumour.

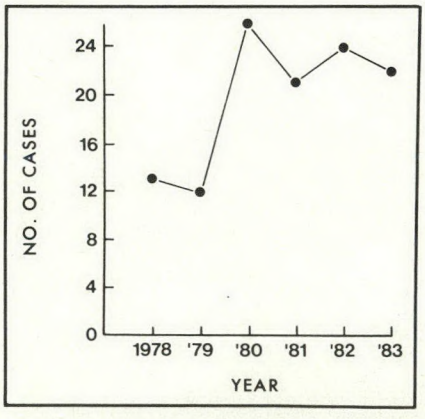


FIG. 1—Distribution of cases of benign ovarian cystic teratoma during 6 years of study.

Findings

Population Distribution

Of the 118 patients, 101 (85.6%) were younger than 40 years while 12 patients (10.2%) were younger than 20 (Fig. 2).

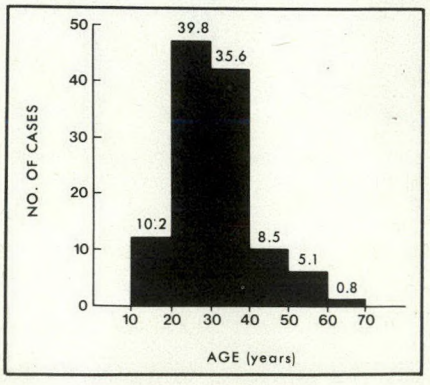


FIG. 2—Age distribution.

Table I—Incidence of Recurrence, Bilaterality and Associated Pregnancy

Recurrence/bilaterality/ pregnancy	Patients no./total no.	%	Reported %[2]
Recurrence	4/118	3.4	
Suspected recurrence	4/118	3.4	
Bilateral	5/118	4.2	11.1
Gross	4/5	80.0	82.0
Microscopic	1/5	20.0	18.0
Pregnancy	8/118	6.8	

The age range was from 13 to 66 years. The incidences of recurrence, bilaterality and a coexisting pregnancy are shown in Table I.

Two patients had recurrence in the contralateral ovary and a third patient had recurrence twice. This patient underwent a right ovarian cystectomy at 18 years of age, a left ovarian cystectomy at 19 years and bilateral ovarian cystectomies at 22 years. Four other patients (3.4%) had undergone ovarian surgery elsewhere previously for unknown conditions.

Symptoms

More than half the patients were completely asymptomatic when the teratoma was discovered (Table II). These masses were diagnosed on routine pelvic examination, roentgenography, ultrasonography, or incidentally at laparotomy. The laparotomies were done for different indications such as suspected ectopic pregnancy, total abdominal hysterectomy and cesarean section. Among the symptomatic patients, the most common symptom was abdominal pain (Table III).

Table II—Diagnostic Test in 64 Asymptomatic Patients With Benign Ovarian Cystic Teratoma

Test	No.	%
Routine pelvic examination	46	71.9
Roentgenography	2	3.1
Ultrasonography	1	1.6
Laparotomy	15	23.4

Table III—Symptoms in 54 of 118 Patients With Benign Ovarian Cystic Teratoma

Symptom	No. (symptoms)	%
Amenorrhea	3	5.6
Menometrorrhagia	15	27.8
Abdominal pain	49	90.7

Table IV—Diagnostic Procedures: Rate of Use and Positive Findings

Procedure	Patients, no./total no.	%
Roentgenography	39/118	33.1
Calcification seen	25/39	64.1
Computerized tomography	1/118	0.8
Ultrasonography	67/118	56.8
Cyst seen	57/67	80.6
Calcification seen	9/67	13.4
Normal appearance (missed)	13/67	19.4

Table V—Operative Findings

Ovarian cyst	No./total no.	%
Left ovary	53/118	44.9
Right ovary	60/118	50.8
Bilateral	5/118	4.2
Diameter, cm		
< 6	39/123	31.7
≥ 6	81/123	65.9
Unknown	3/123	2.4

Table VI—Mode of Surgical Treatment in 118 Patients

Procedure	No. of patients	%
Total abdominal hysterectomy	18	15.3
Cystectomy	54	45.8
Oophorectomy	68	57.6
Other ovary		
Palpated	58	49.2
Bisected	13	11.0
Wedge biopsy	21	17.8
Oophorectomy	15	12.7
Unknown	11	9.3

Diagnostic Procedures

One third of the patients underwent roentgenography and more than half ultrasonography (Table IV). Only one patient had computerized tomography and the tomogram demonstrated the lesion. Calcification was apparent on 64.1% of the roentgenograms. Ultrasonography missed 19.4% of the cysts; calcification was identified in 13.4%.

Mode of Treatment

All patients underwent laparotomy, usually through a Pfannenstiel incision (83.1%). Only 20 patients (16.9%) had a midline incision. Right-sided teratomas were slightly more common than left (Table V). Two thirds of the ovarian teratomas were more than 6 cm in diameter, the largest being 18 cm. The smallest cyst (1.2 cm in diameter) was discovered as a pelvic calcification on the roentgenogram. The patients had a variety of procedures at laparotomy, ranging from a simple ovarian cystectomy to total abdominal hysterectomy and bilateral salpingo-oophorectomy (Table VI). All patients who underwent total hysterectomy were more than 37 years of age and had coexisting uterine disease. The contralateral ovary was simply palpated in half of the patients.

Discussion

It is well known that the majority of benign cystic teratomas of the ovary occur in young women, with a peak incidence between 20 and 40 years of age. It is the most common ovarian tumour in women younger than 20, constituting 38% of ovarian neoplasms.[3] Benign cystic teratomas are known to recur mainly because of incomplete removal of the cyst wall initially. In our series, 60% had de-novo recurrence in the contralateral ovary. Benign cystic teratomas usually do not interfere with pregnancy and may coexist in the same ovary with a corpus luteum cyst. According to the literature,[4] benign cystic teratomas represent 12.3% to 44.0% of all tumours complicating pregnancy. A bimanual examination in early pregnancy should be directed at detecting ovarian masses. Any such mass more

than 6 cm in diameter or persisting beyond the 14th week of gestation should be managed surgically. The recommended time of surgery is after the 12th week of gestation since the fetal loss secondary to the procedure is practically nil.[5] The most common palpable ovarian mass during pregnancy is the corpus luteum cyst, followed by the benign cystic teratoma, then by cystadenoma.[6]

The majority of patients with benign cystic teratomas of the ovary are asymptomatic. The mass is usually discovered on routine pelvic examination, or as calcifications seen in the pelvis during procedures done for some other reason. Psammoma bodies of the serous cystadenomas may show as nonspecific calcifications on roentgenograms and should be considered in the differential diagnosis. Computerized axial tomography can accurately diagnose a teratoma because of the complex appearance of the mass with dividing septae, internal debris, variable attenuation and distinct calcification. Ultrasonography usually shows highly reflective cystic and solid echoes with areas of accoustic shadowing that obscure the back wall of the cyst, suggesting the "tip of the iceberg" sign of a teratoma.[2]

Bilateral benign cystic teratomas represent 11% to 18% of all ovarian tumours. Most are less than 10 cm in diameter. Intraperitoneal rupture occurred preoperatively in one patient (0.8%) in our series and has been reported elsewhere in 1.2% to 1.9% of cases.[7] The perforation may be acute, resulting in signs of intraperitoneal irritation, or may be insidious and fulminant, resulting in matted adhesions up to the diaphragm mimicking gynecologic malignant disease.

Since most patients are in their reproductive years and wish to have children, conservative treatment is recommended. Attempts should be made to conserve the ovary and to remove the cyst wall completely to avoid recurrence. The incidence of torsion of the pedicle is reported to be about 21% and associated infarction 10.8%.[8] In our series the incidence was 3.2% and 2.4% respectively. If the contralateral ovary is normal on intraoperative palpation, it is unlikely to be diseased and surgical manipulation is unnecessary.[9]

Despite the simplicity of the operation and the benign outcome of cystic teratomas, the lesion is associated with a wide array of bizarre symptoms and findings. Benign cystic teratomas may present with chronic thyroiditis secondary to thyroid antibodies formed against thyroid tissue in the mass.[10] In our series one case of struma ovarii occurred in a 51-year-old woman who had a palpable thyroid gland. Familial occurrence of benign cystic teratomas of the ovary in a grandmother, mother and daughter has been reported.[3] A case of bilateral benign cystic teratomas in identical twins with virilizing effects has also been documented.[2]

References

1. NOVAK ER, WOODRUFF JD (eds): *Novak's Gynecologic and Obstetric Pathology, With Clinical and Endocrine Relations*, 8th ed, Saunders, Philadelphia, 1979: 485–502
2. WHEATLEY KK JR, LEMAK LL, SASSO RD: Bilateral benign adult cystic ovarian teratomas: case report and review of complications. *Tex Med* 1983; 79(3): 67–70
3. BRENNER SH, WALLACH RC: Familial benign cystic teratoma. *Int J Gynecol Obstet* 1983; 21: 167–9
4. WITTICH AC: Dermoid cyst of the ovary complicating pregnancy: case report. *Milit Med* 1983; 148: 273–5
5. BOOTH RT: Ovarian tumors in pregnancy. *Obstet Gynecol* 1963; 21: 189–93
6. HASAN A, AMR S, ISSA A, BATA M: Ovarian tumors complicating pregnancy. *Int J Gynecol Obstet* 1983; 21: 279–82
7. STUART GC, SMITH JP: Ruptured benign cystic teratomas mimicking gynecologic malignancy. *Gynecol Oncol* 1983; 16: 139–43
8. PANTOJA E, NOY MA, AXTMAYER RW, COLON FE, PELEGRINA I: Ovarian dermoids and their complications. Comprehensive historical review. *Obstet Gynecol Surv* 1975; 30: 1–20
9. DISAIA PJ, CREASMAN WT (eds): *Clinical Gynecologic Oncology*, 2nd ed, Mosby, St. Louis, 1984
10. NIELSEN VT: A benign cystic teratoma of the ovary with chronic thyroiditis. *Am J Obstet Gynecol* 1984; 148: 1142–4

MARTIN B. BUCKSPAN, MD, FRCSC;* NOEL B. COOTER, MB, BS, FRCPC;†
MORRIS GOLDFINGER, MD, FRCPC;‡ JOEL C. KIRSH, MD, FRCPC‡

Endometriosis: an Unusual Cause of Ureteral Obstruction

Endometriosis is a common disorder, affecting women in the child-bearing years. While urologic involvement is rare, the bladder is more often affected than the ureter. The authors describe the case of a 30-year-old woman who had unilateral ureteral obstruction secondary to an isolated periureteral retroperitoneal area of endometriosis. The theories of histogenesis are discussed. Current treatment consists of surgery or hormonal manipulation or a combination of the two.

L'endométriose est une affection courante touchant les femmes en âge de concevoir. Bien que les atteintes urologiques soient rares, la vessie est plus souvent touchée que les uretères. Les auteurs décrivent le cas d'une femme de 30 ans qui a souffert d'une obstruction uretérale unilatérale consécutive à une endométriose limitée à la région périurétérale rétropéritonéale. On commente les théories de son histogénèse. Le traitement actuel consiste en une intervention chirurgicale, en une manipulation hormonale ou en une combinaison des deux.

Endometriosis is characterized by the presence and proliferation of endometrial epithelium and stroma at a site other than the uterine cavity. It is said to affect up to 20% of women in the child-bearing years.[1] Clinically important urinary involvement is rare, amounting to only 1% of cases, but the bladder is more often affected than the ureter.[2] In the case reported here, ureteral obstruction occurred as a result of a solitary focus of extraperitoneal endometriosis.

*From the *Department of Surgery (Urology), †Department of Pathology and ‡Department of Radiology, Mount Sinai Hospital, University of Toronto, Toronto, Ont.*

Accepted for publication Feb. 19, 1985

Reprint requests to: Dr. Martin B. Buckspan, Department of Surgery (Urology), Ste. 1224, Mount Sinai Hospital, 600 University Ave., Toronto, Ont. M5G 1X5

Case Report

A 30-year-old woman (gravida 2 para 2) complained of pain in the back, left loin and left lower quadrant, which was more severe during menstruation. Gynecologic examination including laparoscopy failed to reveal a cause for her symptoms. A bone scan (Fig. 1) showed left hydroureteronephrosis. Clinically, she had mild flank tenderness, but no pelvic mass or fixation. Further radiologic evaluation confirmed the left hydroureteronephrosis (Fig. 2) and revealed a periureteral mass (Fig. 3) located just below the pelvic brim. At laparotomy, a localized solitary area of retroperitoneal fibrosis, involving the left ureter at the pelvic inlet, was found. A frozen-section diagnosis of endometriosis was made. The dilated ureter was divided as it entered the fibrotic plaque and was reimplanted into a Boari-type flap. The permanent sections confirmed the diagnosis of endometriosis (Figs. 4 and 5).

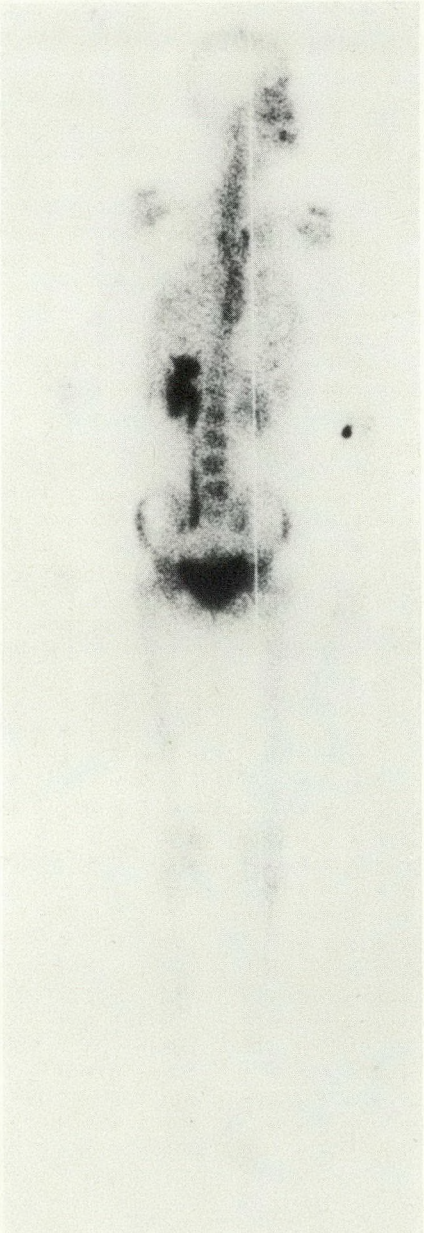


FIG. 1—Technetium-99m methylene diphosphonate bone scan demonstrates left hydroureteronephrosis. Bones are normal.

Discussion

The etiology of endometriosis is unknown. Several theories exist, the most popular suggesting that viable endometrial fragments are regurgitated

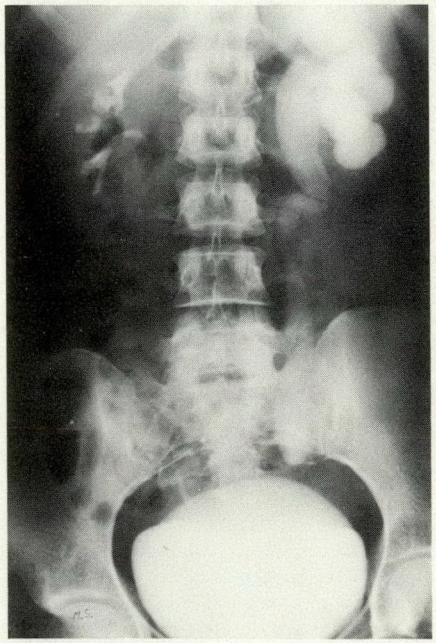


FIG. 2—Preoperative intravenous pyelogram demonstrates left hydroureteronephrosis. Obstruction is just below pelvic brim.

through the Fallopian tubes during menstruation.[3] Other theories to explain the histogenesis include that of serosal metaplasia, in which embryonic cells of Mullerian origin within the peritoneum persist and proliferate under ovarian hormonal stimulation, and possibly the embolization of endometrial tissue along lymphatic or vascular channels.[4] The only proven mechanism for the development of endometriosis is direct implantation, when endometrium is implanted into surgical incisions during an operation in which the uterine cavity is opened.[5]

The ectopic endometrium undergoes the same cyclic change as the uterine endometrium. The response to this periodic bleeding is peritoneal irritation, proliferation of connective tissue, and secondary formation of adhesions of varying severity, involving contiguous pelvic structures.

While endometriosis has been reported to involve all areas of the urinary system,[6-10] clinically significant urinary involvement is uncommon.[11] Ureteral obstruction is rare, which is surprising considering the anatomic relationships within the pelvis.[12,13] Ureteral involvement can be divided into two groups:[14] extrinsic, where the ureter is caught in a fibrotic reaction in the periureteral tissue plane, and intrinsic, where the involvement is transmural. The intrinsic type is less common, but both types generally affect only the pelvic ureter.

The current therapeutic approach includes surgery or hormonal manipulation, or a combination of the two. Surgery may be conservative, preserving reproductive function, or definitive, involving not only resection of the endometrial deposits but total hysterectomy and bilateral oophorectomy. Occasionally, as in our case, surgery is performed to deal with a specific complication. The surgical approach must be tailored to the individual. Certainly when there is extensive involvement, a pelvic mass or fixation, preoperative assessment of the urinary system and preparation of the bowel should be considered.

Endocrine therapy evolved from the early observation that endometriosis undergoes regression during pregnancy and the menopause.[15] This led to the concept that hormonally induced amenorrhea might be beneficial. Pseudopregnancy is a state of hyperhormonal amenorrhea that is induced by the continuous administration of estrogen-progestogen preparations.[16] This results in decidual transformation, necrosis and absorption of the ectopic endometrium.

A more recent approach is the induction of a state called pseudomenopause.[17] Here, complete ovarian suppression leads to hypoestrogenic amenorrhea. This condition is produced by Danazol, a synthetic steroid with antigonadotropic

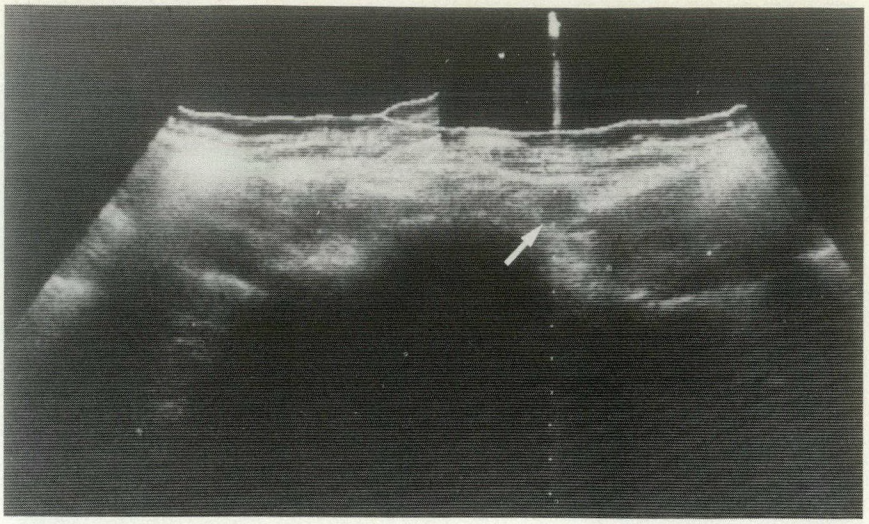


FIG. 3—Transverse sonogram demonstrates 2-cm echo-poor nodule (arrow) in retroperitoneum below pelvic brim.

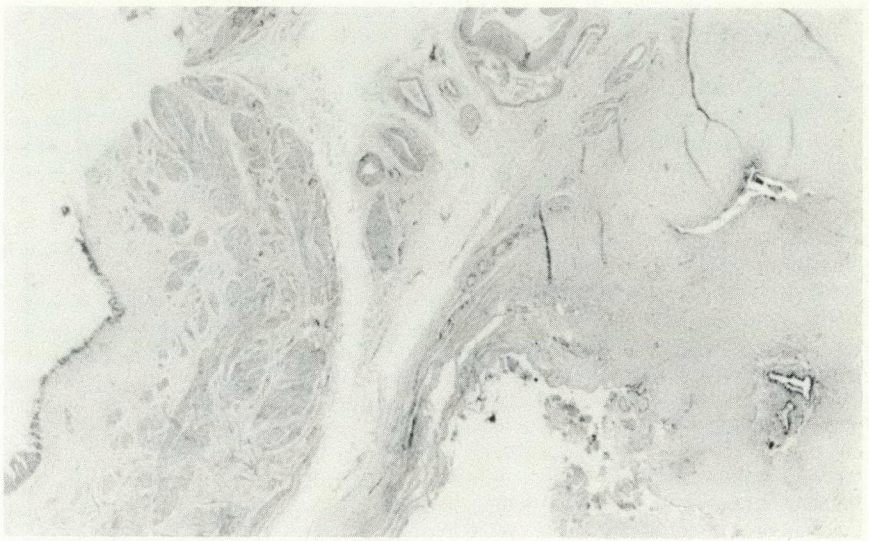


FIG. 4—Transverse section of ureter demonstrates periureteral fibrosis and endometrial glands (hematoxylin and eosin, original magnification × 25).

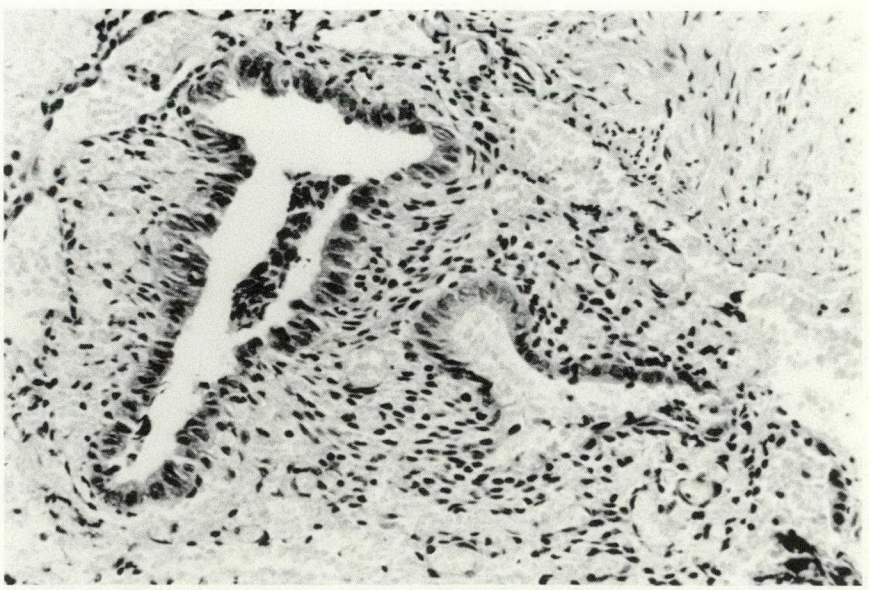


FIG. 5—Higher magnification of endometrial glands and stroma (hematoxylin and eosin, original magnification × 65).

properties. Pseudomenopause appears more effective than pseudopregnancy and may cure up to 70% of cases, especially if the endometriosis is not extensive. Since the etiology of endometriosis is enigmatic, effective conservative treatment to prevent or permanently cure this condition has not been developed.[18] At present, castrating hysterectomy is the only therapy that offers the possibility of permanent control.[19,20]

References

1. JENKINSON EL, BROWN WH: Endometriosis; study of 117 cases with special reference to constricting lesions of rectum and sigmoid colon. *JAMA* 1943; 122: 349-54
2. ABESHOUSE BS, ABESHOUSE G: Endometriosis of the urinary tract: a review of the literature and a report of four cases of vesical endometriosis. *J Int Coll Surg* 1960; 34: 43-63
3. SAMPSON JA: Peritoneal endometriosis due to menstrual dissemination of endometrial tissue into the peritoneal cavity. *Am J Obstet Gynecol* 1927; 14: 422-69
4. JAVERT CT: Pathogenesis of endometriosis based on endometrial homeoplasia, direct extension, exfoliation and implantation, lymphatic and hematogenous metastasis (including 5 case reports of endometrial tissue in pelvic lymph nodes). *Cancer* 1949; 2: 399-410
5. BEISCHER NO: Endometriosis of an episiotomy scar cured by pregnancy. *Obstet Gynecol* 1966; 28: 15-21
6. FEIN RL, HORTON BF: Vesical endometriosis: a case report and review of the literature. *J Urol* 1966; 95: 45-50
7. MILES HB, FALCONER KW: Renal endometriosis associated with hematuria. *J Urol* 1969; 102: 291-3
8. MARSHALL VF: Occurrence of endometrial tissue in kidney; case report and discussion. *J Urol* 1943; 50: 652-6
9. MASLOW LA, LEARNER A: Endometriosis of kidney. *J Urol* 1950; 64: 564-6
10. GOODALL JR: Urinary complications of pelvic endometriosis. *Ann Surg* 1944; 120: 891-900
11. KERR WS JR: Endometriosis involving the urinary tract. *Clin Obstet Gynecol* 1966; 9: 331-57
12. STANLEY KE, UTZ DC, DOCKERTY MB: Clinically significant endometriosis of the urinary tract. *Surg Gynecol Obstet* 1965; 120: 491-8
13. KAPLAN JH, KUDISH HG: Endometrial obstruction of ureter. *Urology* 1974; 3: 327-9
14. SLUTSKY JN, CALLAHAN D: Endometriosis of the ureter can present as renal failure: a case report and review of endometriosis affecting the ureters. *J Urol* 1983; 130: 336
15. MCARTHUR JW, ULFELDER H: The effect of pregnancy upon endometriosis. *Obstet Gynecol Surv* 1965; 20: 709-33
16. KISTNER RW: The effects of new synthetic progestogens on endometriosis in the human female. *Fertil Steril* 1965; 16: 61-80
17. DMOWSKI WP: Current concepts in the management of endometriosis. *Obstet Gynecol Annu* 1981; 10: 279-311
18. SMITH T: The surgical treatment of endometriosis. *Clin Obstet Gynaecol* 1978; 5: 557-70
19. WILLIAMS TJ: The role of surgery in the management of endometriosis. *Mayo Clin Proc* 1975; 50: 198-203
20. ALPER MM, BARWIN N, JOLLY EE: Endometriosis: a therapeutic dilemma. *Mod Med Can* 1984; 39: 455

DAVID R. GRANT, MD, FRCSC;* RICHARD J. FINLEY, MD, FRCSC†

Empyema: Analysis of Treatment Techniques

Empyema is associated with a high mortality. To study the factors responsible for the failure of treatment, the authors reviewed 90 cases of nontuberculous thoracic empyema seen at the University of Western Ontario in London, between 1970 and 1980. The most common causes of empyema were bronchopulmonary infections (63%), complications of pulmonary surgery (14%) and secondary infections of hydrothoraces or hemothoraces (13%). In 51 patients (57%) the condition was acquired in hospital or was related to previous medical therapy. Nine cases were recognized only at autopsy.

The treatment of empyema was assessed in 81 patients, who received an average of 2.2 antibiotics during the course of treatment. Five patients received antibiotics as the only therapy; one died. Seventy-two patients were treated by surgical drainage; 35 (49%) were cured and 18 (25%) subsequently died. Twelve of 18 decortication procedures were successful including 4 performed as a primary procedure and 8 as a secondary procedure. Five of seven patients who underwent thoracoplasty were cured. The overall mortality in the series was 23%.

Prevention and early recognition of empyema may reduce the mortality. Patients who do not improve promptly with surgical drainage may benefit from early decortication.

L'empyème est accompagné d'une forte mortalité. Dans le but d'étudier les facteurs responsables des échecs de traitement, les auteurs ont étudié 90 cas d'empyème thoracique non tuberculeux vus à la University of Western Ontario de London, entre 1970 et 1980. Les causes les plus fréquentes d'empyème ont été les infections bronchopulmonaires (63%), les complications d'interventions chirurgicales pulmonaires (14%) et les infections secondaires d'hydrothorax ou d'hémothorax (13%). Chez 51 patients (57%), il s'agissait d'une infection d'hôpital ou d'une infection reliée à un traitement préalable. Neuf cas n'ont été constaté qu'à l'autopsie.

Le traitement de l'empyème a pu être évalué chez 81 patients qui ont reçu en moyenne 2.2 antibiotiques. Pour cinq patients, l'antibiothérapie a constitué l'unique traitement; un est mort. Soixante-douze patients ont été traités par drainage chirurgical; 35 (49%) ont été guéris et 18 (25%) sont morts subséquemment. Douze interventions de décortication sur 18 ont été couronnées de succès, dont 4 interventions primaires et 8 secondaires. Cinq des sept patients qui ont subi une thoracoplastie ont été guéris. Dans l'ensemble la mortalité a été de 23%.

La prévention et le diagnostic précoce de l'empyème sont susceptibles de réduire la mortalité. Les patients qui ne s'améliorent pas après un drainage chirurgical peuvent bénéficier d'une décortication immédiate.

From the Department of Surgery, University Hospital and Victoria Hospital, University of Western Ontario, London, Ont.

**Research Fellow, Department of Surgery, University of Western Ontario*

†Associate Professor of Surgery, University of Western Ontario

Accepted for publication May 21, 1985

Reprint requests to: Dr. R. Finley, Victoria Hospital, 375 South St., London, Ont. N6A 4G5

The current treatment for empyema is based on work done by Evarts Graham in 1915. He used surgical drainage to treat young soldiers with empyema at Camp Lee, Virginia, and reported an early mortality of only 4%.[1] Because of his excellent results, surgical drainage was adopted by most surgeons as the standard initial therapy for thoracic empyema.

Unfortunately, modern surgeons cannot match Evarts Graham's success. Recent studies report death rates ranging from 15% to 30%, despite the use of

potent antibiotics and modern surgical techniques.[2-4] This difference is likely due to the changing etiology of empyema. Most of Graham's patients were young men with postpneumonic infections. Today, the patient with empyema is often elderly, debilitated and immunosuppressed. Many have gram-negative, anaerobic or mixed infections. For these reasons, the treatment of empyema that worked so well in 1915 is less effective today.

To improve the outcome in this condition, we may have to modify the traditional management. We reviewed 90 cases of empyema seen at the University of Western Ontario between 1970 and 1980 to determine the results of treatment and to identify factors associated with success or failure of therapy.

Patients

The charts of all patients with a diagnosis of thoracic empyema, seen in the three teaching hospitals of the University of Western Ontario between 1970 and 1980, were reviewed. Only those with positive cultures of pleural fluid or frank pus in the pleural cavity were included.

There were 61 males and 29 females, ranging in age from 1 to 91 years (median 53 years). Nine cases were identified at the time of autopsy, and these patients were included in the data on etiology and diagnosis. The results of treatment are reviewed in the remaining 81 patients.

Findings

Etiology

In 39 (43%) of the 90 patients, the empyema was acquired in the community; in the remaining 51, the condition either developed in hospital or resulted from previous medical therapy. The common causes of empyema included bronchopulmonary infections (63%), complications of pulmonary surgery (14%), secondary infections of pleural effusions or hemothoraces due to pneumonias acquired in hospital or contamination from thoracentesis (13%), complications of esophageal surgery (4%) and secondary spread of intra-abdominal infections (4%). Seven cases occurred after trauma from motor vehicle accidents.

Forty-eight patients (53%) had one or more risk factors associated with decreased host resistance to infection, including malnutrition, alcohol abuse, malignant disease, diabetes mellitus, severe liver or renal disease, or were receiving steroids or antineoplastic therapy. Eight patients had respiratory disease and 24 had cardiovascular disease.

Diagnosis

Patients with empyema presented with cough (61 patients, 68%), shortness of breath (55 patients, 61%) and fever (54 patients, 60%). Fatigue, weight loss and chest pain were also common complaints. The diagnosis was established by thoracentesis in 45 patients (50%), thoracostomy or thoracotomy in 36 (40%) and at autopsy in 9 (10%).

The initial culture of the pleural fluid was positive in 81 patients (90%). In these patients, mixed bacterial infections (30 patients, 37%) and anaerobic infections (26 patients, 32%) were common. The most frequent gram-positive aerobes included *Staphylococcus* sp, β-hemolytic streptococci, pneumonococcus and *Streptococcus viridans*. The most frequent gram-negative aerobes included *Pseudomonas aeruginosa*, *Escherichia coli* and *Klebsiella pneumoniae*. The common anaerobes were micrococcal streptococcus, anaerobic streptococcus and *Bacteroides fragilis*.

Treatment

The 81 patients with empyema whose treatment was studied received an average of 2.2 different antibiotics during the course of treatment. In eight of the patients, the antibiotic therapy was suboptimal because of an inadequate dose, oral administration or failure to cover the bacteria that were cultured. Treatment with antibiotics and thoracentesis resulted in four cures and one death — in a patient with alcoholic cirrhosis, who was critically ill at the time of presentation.

Seventy-two patients had a surgical drainage procedure, either a tube thoracostomy alone (50), or combined with a rib resection (22). When surgical drainage was used as the primary treatment, 35 patients (49%) were cured and 18 (25%) subsequently died. Of the 37 patients with failed surgical drainage, 5 were left with persistent chest-tube drainage, 14 underwent pulmonary decortication, 4 thoracoplasty and 14 died without having another surgical procedure (Fig. 1).

Surgical drainage failed in 61% of those with hospital-acquired infections (27 patients), in 65% with mixed infections (18 patients) and in 61% of those who were immunocompromised (28 patients). Of the 45 patients with hospital-acquired infections who were treated with surgical drainage, 17 (38%) died. Of 11 patients with secondary infections of pleural effusions or hemothoraces due to pneumonias acquired in hospital or contamination at the time of thoracentesis, 8 (73%) died after surgical drainage.

Eighteen patients had decortication, which included removal of visceral pleura and radical débridement of the abscess cavity; 12 of them were cured but the procedure failed in 6, including 2 who died. Decortication was performed in 14 patients who already had undergone surgical drainage. In this group, which included the two who died, one was left with a persistently draining chest tube, three failed to improve but later underwent successful thoracoplasty and the rest were cured. The three patients who failed to improve with decortication had parenchymal lung disease (previous left upper lobe resection, large lung abscess in a diseased lobe separate from the empyema and restrictive lung disease from an old tuberculous infection).

Of the seven patients who underwent thoracoplasty, five were cured and there were two sudden unexplained deaths.

Overall, of the 81 patients whose treatment for empyema was studied 19 died (23%).

Discussion

Surgical drainage was adopted as the standard initial therapy for the treatment of thoracic empyema on the basis of Evarts Graham's excellent results reported in 1915.[1]

Recent studies of patients with empyema have reported mortality ranging from 25% to 30%.[2-6] The etiology of empyema has undergone considerable change since Graham's time, and this may explain why his methods are less effective today. In the past, most patients with empyema were young and the infectious agent was usually β-hemolytic streptococcus or *Staphylococcus* sp. In contrast, over half of our patients were older than 40 years, many were immunocompromised and gram-negative anaerobic

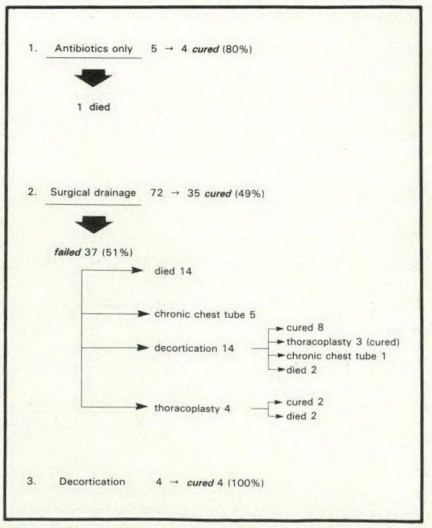


FIG. 1—Treatment of thoracic empyema at University of Western Ontario, 1970 to 1980.

infections were common. The overall mortality in patients treated for an empyema at our institution between 1970 and 1980 was 23%.

What changes can be made to improve these results? Over half of our cases of empyema were due to iatrogenic infections, and these patients accounted for over 80% of the deaths in this series. These data emphasize the importance of standard measures that might prevent hospital-acquired empyema, including vigorous postoperative physiotherapy to reduce the incidence of pulmonary infection, appropriate antibiotic therapy for pneumonias and strict aseptic technique when performing diagnostic or therapeutic thoracentesis.

In 10% of our cases, the empyema was not diagnosed until autopsy. Thus, acute awareness is needed to avoid missing the diagnosis and delaying treatment. Any patient with a fever and a pleural effusion should be considered to have empyema until proven otherwise. Although a chest roentgenogram will usually localize the empyema, computerized tomography or ultrasonography may help in difficult cases.

Adequate drainage of the pleural space is still the key element in the treatment of empyema; 49% of our patients were successfully treated with a drainage procedure alone. Patients who do not improve quickly with chest-tube drainage may benefit from decortication. Recent reports have shown that decortication can be accomplished with a low morbidity and mortality, even in debilitated patients.[7-9] This allows the surgeon to remove all the infected tissue and pus, it avoids the debilitating effects of prolonged drainage and improves pulmonary function by removing the restrictive pulmonary peel.

Our data identified groups of patients with empyema who did not have a good response to drainage procedures. Patients with anaerobic infections, hospital-acquired infections, secondary infections of the pleural space and those with depressed immunity may benefit from early decortication.

In our review, 18 patients had a pulmonary decortication (14 after surgical drainage) and this procedure was successful in 12. Patients in whom decortication failed included two who died of ongoing sepsis, one who had persistent chest-tube drainage and three who subsequently underwent a thoracoplasty and were cured.

Thoracoplasty is an effective treatment for empyema in selected patients. Seven of our patients had a thoracoplasty: five were cured and two died. Three patients who failed to improve with decortication had parenchymal lung disease which may have prevented the lung from re-expanding. These patients were cured with a subsequent thoracoplasty. If patients with empyema and parenchymal lung disease do not respond to surgical drainage, thoracoplasty should be combined with decortication as the next procedure.

Thoracic empyema is still common and unfortunately often fatal. Prevention, early recognition and prompt, effective treatment may reduce the morbidity and mortality associated with this condition.

References

1. GRAHAM EA, BELL RD: Open pneumothorax: its relation to the treatment of acute empyema. *Am J Med Sci* 1918; 156: 8398–840
2. SHERMAN MM, SUBRAMANIAN V, BERGER RL: Management of thoracic empyema. *Am J Surg* 1977; 133: 474–9
3. EMERSON JD, BORUCHOW IB, DAICOFF GR, BARTLEY TD, WHEAT MW JR: Empyema. *J Thorac Cardiovasc Surg* 1971; 62: 967–72
4. SIMMONS EM, SAUER P, ELKADI A, MACKENZIE IW, ALMOND CH: Review of nontuberculous empyema at the University of Missouri Medical Center from 1957 to 1971. *J Thorac Cardiovasc Surg* 1972; 64: 578–85
5. CLAGETT OT: Changing aspects of the etiology and treatment of pleural empyema. *Surg Clin North Am* 1973; 53: 863–6
6. FINLAND M, BARNES MW: Changing ecology of acute bacterial empyema: occurrence and mortality at Boston City Hospital during 12 selected years from 1935 to 1972. *J Infect Dis* 1978; 137: 274–91
7. MAYO P, MCELVEIN RB: Early thoracotomy for pyogenic empyema. *Ann Thorac Surg* 1966; 2: 649–57
8. MORIN JE, MUNRO DD, MACLEAN LD: Early thoracotomy for empyema. *J Thorac Cardiovasc Surg* 1972; 64: 530–6
9. FISHMAN NH, ELLERTSON DG: Early pleural decortication for thoracic empyema in immunosuppressed patients. *J Thorac Cardiovasc Surg* 1977; 74: 537–41

JULIE RIGHTER, MD, FRCPC;* JOHN M. WOODS, MD, FRCSC, FACS†

Campylobacter and Endovascular Lesions

Because of the gaps in our knowledge of the epidemiology and pathogenesis of *Campylobacter* infections, particularly the propensity of *Campylobacter fetus* ssp *fetus* to infect vascular endothelium, the authors describe the case of a 56-year-old woman with *C. fetus* ssp *fetus* infection of an aortic aneurysm. She recovered after a one-stage surgical repair and antibiotic therapy with erythromycin.

The organism was cultured from samples of the stool and tissue obtained at operation. It was identified from its typical characteristics: morphology, microaerophilic, able to grow at 22°C and 37°C but not at 42°C, catalase and oxidase positive and resistant to nalidixic acid but susceptible to cephalothin.

Considèrant les lacunes des connaissances actuelles sur l'épidémiologie et la pathogénèse des infections à *Campylobacter*, et particulièrement sur l'affinité de *Campylobacter fetus* variété *fetus* pour l'endothélium vasculaire, les auteurs décrivent le cas d'une femme de 56 ans souffrant d'une infection à *C. fetus* variété *fetus* colonisant un anévrisme de l'aorte. La guérison a suivi une réparation chirurgicale en une étape accompagnée d'une antibiothérapie à l'érythromycine.

Le microorganisme a pu être cultivé des échantillons de selles et des tissus prélevés à l'opération. Il a été identifié à ses caractéristiques typiques: morphologie, microaérophile, capable de pousser à 22°C comme à 37°C mais incapable à 42°C, catalase et oxydase positif, résistant à l'acide nalidixique mais sensible à la céphalothine.

From the Department of Laboratory Medicine and Department of Surgery, Toronto East General and Orthopaedic Hospital, Toronto, Ont.

**Assistant Professor, Department of Microbiology, University of Toronto*

†Surgeon-in-Chief, Toronto East General and Orthopaedic Hospital; Assistant Professor, Department of Surgery, University of Toronto

Accepted for publication Mar. 26, 1985

Reprint requests to: Dr. Julie Righter, Head, Division of Microbiology, Toronto East General and Orthopaedic Hospital, 825 Coxwell Ave., Toronto, Ont. M4C 3E7

Like *Salmonella, Campylobacter fetus* ssp *fetus* has an apparent propensity to infect vascular endothelium, although proof with the latter is rare. This bacterium has

been called by various names. According to Skerman and associates,[1] the genus *Campylobacter* contains three pathogenic species, *C. jejuni, C. coli* and *C. fetus*, the last being divided into two subspecies, *fetus* and *venerealis*. The incidence of *Campylobacter* infection in endovascular lesions is unknown and unless appropriate bacteriologic techniques are used, we will not be able to diagnose these infections. We describe such a case to illustrate the characteristic findings and appropriate investigations, and to stimulate others to seek the diagnosis and thus fill in some of the gaps in our knowledge of *Campylobacter* syndromes.

Case Report

A 56-year-old woman gave a history of having crampy abdominal pain associated with nausea and diarrhea without blood or mucus for 2 months. She was afebrile, her blood pressure was 140/90 mm Hg and pulse rate 84 beats/min. An abdominal aortic aneurysm was palpable. The hemoglobin value was 136 g/L and the leukocyte count was 12.1 × 10^9/L with 80% neutrophils. Stool sent for culture was lost in transit.

She improved with nonspecific therapy. Nineteen days after admission she underwent elective resection of the aneurysm and tube-graft aortic reconstruction. Extensive inflammatory tissue was noted in the retroperitoneum, adherent to the aorta. This tissue, and stool collected 4 days later, grew *C. fetus* ssp *fetus*. She received a course of erythromycin (500 mg orally four times daily for 7 days). Blood cultures drawn while on this therapy were sterile. She made a smooth recovery and was alive 3 years later, with no evidence of recurrence.

The organism was identified on the basis of typical morphology (curved gram-negative bacilli) and motility, along with the following characteristics of *C. fetus* ssp *fetus*: microaerophilic, able to grow at 22°C and 37°C but not at 42°C, oxidase and catalase positive, resistant to nalidixic acid and susceptible to cephalothin.

Discussion

Most cases of *Campylobacter* endovascular infections are incompletely documented. In one patient with septicemia, endocarditis was proven, but organisms could not be recovered at autopsy.[2] Six patients had thrombophlebitis and *Campylobacter* septicemia;[3-7] in at least three of these the isolate was clearly *C. fetus* ssp *fetus*.[4,5,7] Examination of inflamed femoral veins from one patient at autopsy failed to reveal organisms.[3]

In most reported *Campylobacter* infections of aneurysms, the role of the organism is uncertain. Loeb and associates[8] described a patient with a femoral artery aneurysm and *Campylobacter* septicemia. Three patients with *C. fetus* ssp *fetus* septicemia died of ruptured aortic aneurysms;[9-11] cultures from two at autopsy were negative, but antibiotics had been given.

The present report and one by Marty and associates[12] describe the only two patients with localized endovascular infections proven by culture. The other patient also had an infected abdominal aortic aneurysm; culture of arterial blood and aortic wall tissue grew *C. fetus* ssp *fetus*. It is interesting that both patients were successfully treated with a one-stage surgical repair.

Campylobacter fetus ssp *fetus* causes three distinct syndromes: localized infection (often accompanied by septicemia), cryptogenic septicemia (a benign entity) and relapsing septicemia (in immunocompromised patients).[7] The association of the organism with vascular endothelial lesions is noteworthy.

Awareness of *C. fetus* ssp *fetus* as a potential pathogen is essential since it may be missed by usual bacteriologic techniques. Little is known about the epidemiology and pathogenesis of this infection. Previous reports have used various systems of nomenclature and often the organism was not fully identified. It is vital to distinguish *C. fetus* ssp *fetus* from *C. jejuni* whenever *Campylobacter* is cultured from any unusual infection in order that we may gain a clearer understanding of the diseases caused by these organisms.

References

1. SKERMAN VBD, MCGOWAN V, SNEATH PHA: Approved lists of bacterial names. *Int J Syst Bacteriol* 1980; 30: 225–420
2. LEE MY, LUDWIG J, GERACI JE, WASHINGTON JA II: Fatal *Vibrio fetus* endocarditis: report of one case and review of the literature. *Virchows Arch* [*Pathol Anat*] 1970; 350: 87–94
3. KAHLER RL, SHELDON H: *Vibrio fetus* infection in man. *N Engl J Med* 1960; 262: 1218–22
4. BLASIUS C, ULLMANN U, ACHINGER R: [*Vibrio fetus* sepsis in thrombophlebitis.] *Zentralbl Bakteriol* [*Orig*] 1970; 214: 17–22
5. LAWRENCE R, NIBBE AF, LEVIN S: Lung abscess secondary to *Vibrio fetus*, malabsorption syndrome and acquired agammaglobulinemia. *Chest* 1971; 60: 191–4
6. VESELY D, MACINTYRE S, RATZAN KR: Bilateral deep brachial vein thrombophlebitis due to *Vibrio fetus*. *Arch Intern Med* 1975; 135: 994–5
7. RIGHTER J, WELLS WA, HART GD, MCNEELY DJ: Relapsing septicemia caused by *Campylobacter fetus* subsp. *fetus*. *Can Med Assoc J* 1983; 128: 686–9
8. LOEB H, BETTAG JL, YUNG NK, KING S, BRONSKY D: *Vibrio fetus* endocarditis. Report of 2 cases. *Am Heart J* 1966; 71: 381–6
9. FILE TM JR, BARNISHAN J, FASS RJ: *Campylobacter fetus* sepsis with mycotic aortic aneurysm. *Arch Pathol Lab Med* 1979; 103: 143–5
10. DOLEV E, ALTMANN G, PADEH B: *Vibrio fetus* septicemia. A case report. *Isr J Med Sci* 1971; 7: 1188–91
11. TAYLOR PR, WEINSTEIN WM, BRYNER JH: *Campylobacter fetus* infection in human subjects: association with raw milk. *Am J Med* 1979; 66: 779–83
12. MARTY AT, WEBB TA, STUBBS KG, PENKAVA RR: Inflammatory abdominal aortic aneurysm infected by *Campylobacter fetus*. *JAMA* 1983; 249: 1190–2

JAMES MAHONEY, MD, FRCSC

Treatment of the Chronically Infected Median Sternotomy Wound With Muscle Flaps

While infection and dehiscence of the median sternotomy wound is a serious complication, débridement, sternal rewiring and wound irrigation will often result in wound healing. However, if these measures fail, radical débridement of all infected tissue and immediate reconstruction with muscle flaps is required and will give excellent results. The pectoralis major muscle based on the thoracoacromial artery is most satisfactory for this reconstruction. The rectus abdominis muscle, while also used, is not as effective because of variations in its proximal blood supply.

The author describes 10 patients with chronically infected median sternotomy wounds, seen at St. Michael's Hospital in Toronto, in whom use of these techniques led to a rapid recovery with few complications.

L'infection et le lâchage des sutures représentent de sérieuses complications de sternotomie médiane. Le débridement, la pose de nouvelles broches sternales et l'irrigation de la plaie entraînent généralement la guérison. Lorsque ces mesures échouent un débridement radical du tissu infecté et une reconstruction immédiate avec des lambeaux musculaires sont requis et donnent d'excellents résultats. Le grand pectoral irrigué par l'artère acromio-thoracique est jugé des plus satisfaisants pour cette reconstruction. Bien qu'il soit aussi utilisé, le grand droit de l'abdomen est moins efficace à cause des variations de son apport sanguin proximal.

L'auteur décrit 10 patients vus au St-Michael's Hospital de Toronto alors qu'ils étaient porteurs d'infections chroniques de plaies de sternotomies médianes, et chez qui ces techniques ont entraîné une guérison rapide avec de rares complications.

From the Division of Plastic Surgery, Department of Surgery, St. Michael's Hospital, University of Toronto, Toronto, Ont.

Accepted for publication Apr. 9, 1985

Reprint requests to: Dr. J. Mahoney, Ste. 206, 55 Queen St. E., Toronto, Ont. M5C 1R6

Dehiscence of the median sternotomy wound with chronic infection is a serious complication. Aggressive early débridement of the wound followed by sternal rewiring and continuous wound irrigation[1] is successful in 90% of early cases,[2] but if this fails, the morbidity and mortality are high.[3] Radical débridement of the sternum and adjacent cartilage is then necessary but results in an extensive bone and soft-tissue defect. In the past, these wounds were allowed to heal by secondary intention or were skin grafted. Recent reconstruction of the soft-tissue defect with muscle flaps, musculocutaneous flaps and omentum[4-7] has lowered the morbidity and mortality. These flaps provide excellent vascularized tissue to fill the defect, obliterate dead space and protect the underlying structures.

Another group of patients who require this type of management are those with single or multiple sinus tracts. Frequently, they have been discharged from hospital with a healed sternal wound and initially present with evidence of infection several months after the operation. The approach to treatment in these cases should be aggressive because the infection tends to recur following surgical treatment.[8] Sternal resection followed by reconstruction is usually necessary.

We have used pectoralis major and rectus abdominis muscle flaps following radical débridement of the sternal wound. The purpose of this paper is to present the experience of our group at St. Michael's Hospital in Toronto with these flaps and to describe the technical refinements we have made.

Patients

The charts of 10 consecutive patients with major sternal infections treated at St. Michael's Hospital between June 1981 and December 1983 were reviewed. Seven represented failure of standard management of sternal dehiscence or wound infection that consisted of débridement, rewiring and wound irrigation. Osteomyelitis and mediastinitis developed in all patients and eight were critically ill as a result. Eight patients were treated within 2 months of their cardiac operations. Two patients had chronic osteomyelitis of the sternum; one was seen 1 year after and the second 3 years after the original procedure. The courses of these patients are summarized in Table I.

Surgical Techniques

All infected material including skin, sternum and costal cartilage is radically debrided. Frequently, the entire sternum and adjacent cartilage must be removed (Figs. 1 and 2), especially when secondary rewiring has been performed as in 9 of our 10 patients. In chronic osteomyelitis, multiple sinus tracts often involve cartilage, which must be excised back to the costochondral junction. In the vicinity of the costal arch care must be taken to preserve the internal mammary and superior epigastric vessels. The manubrium is debrided to healthy appearing bone. Tissue overlying the heart is gently removed. Some granulation tissue and fibrinous exudate is often left in this area. After the wound is irrigated extensively, the defect is closed with muscle flaps, using one or both pectoralis major muscles and often the rectus abdominis muscle.

The pectoralis major muscle is dissected as follows. Initially, it is freed from the overlying soft tissues. The origin of the sternal portion is completely detached if this has not already been done during the radical débridement. The origin of the clavicular head is preserved. The lateral border is freed from its soft-tissue attachments. Occasionally, simple muscle advancement to the midline will provide adequate coverage of the defect as in two of our patients. If additional tissue is required, the insertion of the sternal head into the humerus is divided to mobilize the muscle further. A second incision in

the region of the deltopectoral groove can be made but this can also be done through the central incision. The muscle is then rotated on its thoracoacromial vascular pedicle into the defect. Often only one muscle needs to be mobilized in this fashion but both may be necessary if a large defect is present or the muscles are small.

In one patient the muscle was not used in this fashion but was "turned over", preserving the internal mammary blood supply while dividing the thoracoacromial pedicle. We have found it more satisfactory to divide the internal mammary vessels as these may have been damaged during the débridement.

Large defects involving the lower one third of the sternum may not be adequately covered with the pectoralis major muscles alone. This area is very well covered by the rectus abdominis muscle based on the superior epigastric artery. The muscle is dissected by making a paramedian incision from the lower end of the sternal incision to the level of the umbilicus. The anterior sheath is incised. The muscle is carefully dissected from the sheath, care being taken to preserve the superior epigastric vessels. Once adequate length has been obtained, the muscle and inferior epigastric vessels are transected and the proximal vascular pedicle is dissected as necessary to allow the muscle to rotate 180°, filling in the lower chest defect. The anterior sheath is then closed.

The mobilized pectoralis and rectus abdominis muscles are approximated in the midline (Figs. 3 and 4), completely covering the debrided area and filling in the soft-tissue defect. Numerous suction drains are inserted to help control fluid accumulation and obliterate dead space. One is placed beneath the muscle flaps, two beneath the skin and two laterally in each area of pectoralis detachment. The skin is then closed primarily. An elastic chest binder is applied over a well-padded dressing.

Suction drains are removed 1 week after operation. Antibiotics are given intravenously for 1 week than orally for 3 weeks, according to culture and sensitivity findings. The patients wear the chest binder for 1 month after the operation.

Results

Most patients recovered rapidly and were discharged from hospital 2 weeks after operation. Major complications were few. One patient suffered a pulmonary embolism. One died early postoperatively from refractory congestive heart failure and renal failure. Sternal infection recurred in one patient. This was thought to be a failure of reconstruction rather

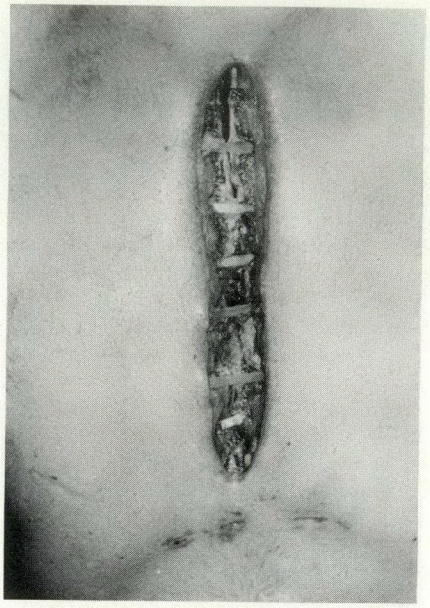


FIG. 1—Infected sternal wound following débridement and wound irrigation.

FIG. 2—Defect following total sternectomy and removal of costal cartilage.

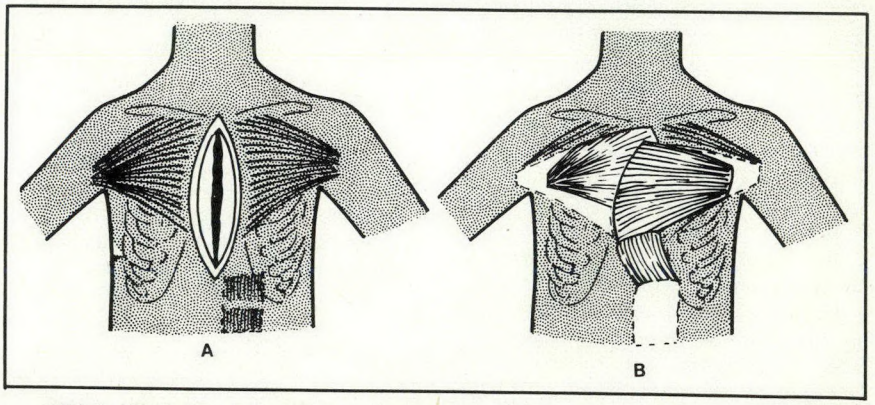


FIG. 3—Technique of muscle reconstruction using bilateral pectoralis and rectus abdominis muscles.

Table I—Data on 10 Patients With Chronic Sternal Infections

Patient no.	Age, yr	Sex	Operation	Organism	Procedure	Outcome
1	62	M	CABG, MV	*Enterobacter aerogenes*	Bilateral pectoralis, bilateral rectus	Recurrence of infection
2	66	F	CABG	Diphtheroids	Bilateral pectoralis	Healed without complication
3	71	M	CABG	—	Bilateral pectoralis, right rectus	Healed without complication
4	29	M	(Trauma)	—	Bilateral pectoralis, right rectus	Healed without complication
5	68	M	CABG	*Enterobacter*	Bilateral pectoralis, left rectus	Hematoma, healed
6	57	M	CABG	*Klebsiella* sp	Bilateral pectorallis, left rectus	Died 2 d postop
7	63	M	CABG	*Staphylococcus epidermidis*	Bilateral pectoralis, right rectus	Healed without complication
8	66	M	CABG	*S. epidermidis*	Bilateral pectoralis, right rectus	Healed without complication, pulmonary embolism
9	65	M	CABG	*Staphylococcus aureus*	Bilateral pectoralis, right rectus	Healed without complication
10	71	M	CABG	Diphtheroids	Bilateral pectoralis, right rectus	Healed without complication

CABG = coronary artery bypass grafting, MV = mitral valve replacement.

than inadequate débridement, as at re-exploration 48 hours after his initial reconstructive procedure the rectus muscle and one pectoralis muscle were found to be necrotic. The defect had been reconstructed with the pectoralis turnover muscle flaps, and although the rectus abdominis muscle had been used in the described fashion, the superior epigastric vessels could not be identified. This aspect will be discussed further.

Discussion

When débridement, rewiring and wound irrigation of the sternum fail to heal an infected median sternotomy wound or when chronic osteomyelitis has developed, complete débridement of all infected tissue followed by reconstruction is the treatment of choice. New reconstructive techniques using well-vascularized soft tissue in the form of muscle have given us the means to carry this out. Healthy tissue with a new blood supply is brought into the contaminated field and this has resulted in decreased morbidity and mortality.[4] It is important that the muscles used for this be reliable. Based on our laboratory and clinical experience, we have improved the use of the muscles normally used for the reconstruction.

The blood supply to the pectoralis major muscle is from the intercostal perforators of the internal mammary, the lateral pectoral and the thoracoacromial vessels. The pectoralis major muscle, based on the thoracoacromial vessel, is reliable, but the turnover flap of this muscle, based on the internal mammary vessels, is less so for several reasons. The internal mammary vessels may have been divided at the previous surgery. If still intact, the perforators to the pectoralis major muscle have often been interrupted during the débridement. These factors account for the one treatment failure. Unfortunately, in this same patient the rectus abdominis muscle also failed because of an inadequate blood supply.

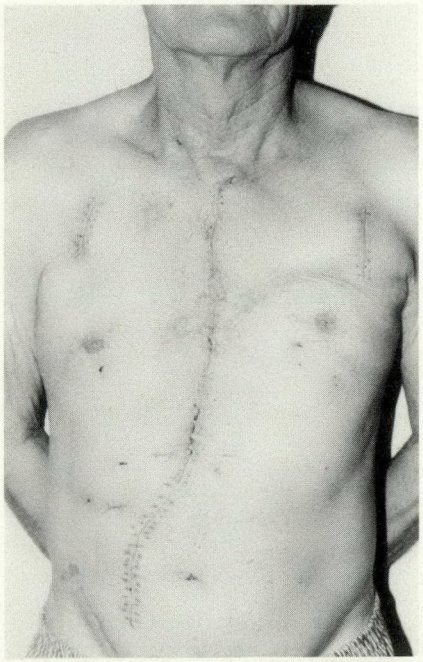


FIG. 4—Healed sternal wound 2 weeks after reconstruction.

The blood supply to the rectus abdominis muscle is from the superior epigastric vessels (terminal branches of the internal mammary), intercostal arteries and the inferior epigastric system. Anatomically, the superior epigastric vessels vary as to their size and distribution.[9]

We have verified this in our anatomical dissections. In addition, they may also be interrupted at the previous surgery. We therefore perform selective angiography of the internal mammary superior epigastric vessels to verify their patency preoperatively. Complete interruption of the internal mammary vessel on one side was identified preoperatively in two patients, so we used the normal side at surgery. Further, based on our clinical findings of bleeding at the end of the muscle, the supraumbilical portion is in our opinion the most reliable, especially when multiple transverse fibrous bands are present in the muscle and the longitudinal vessels appear attenuated. With these modifications we have not had any further problems related to the rectus abdominis muscle flap.

Muscle has been used to cover many different contaminated wounds. Uncomplicated healing following removal of all infected material and primary reconstruction has become common.[10] The benefit and reliability of muscle flaps in this situation has also been demonstrated experimentally.[11]

In most of these patients, the entire sternum was infected so that total removal was necessary, making sternal approximation impossible. Although some stabilization of the chest following removal of the sternum would be expected to be necessary, this has not been the case. After a short period of postoperative ventilation, patients had few problems with respiratory function. It is likely that the soft tissues are fixed to the surrounding structures, preventing respiratory paradox. The use of foreign material or autogenous bone to improve chest contour is contraindicated.

Eight of our patients were gravely ill at the time of operation and often had serious associated diseases, such as chronic lung disease, congestive heart failure, diabetes mellitus and obesity, which increased their difficulties. We believed that débridement and reconstruction in one stage would be the best approach and this was indeed the case. Convalescence was usually rapid. Careful attention to nutritional status led to an early discharge.

We concluded that the sternal portion of the pectoralis major muscle, based on the thoracoacromial vessels, is reliable and may suffice for the reconstruction. Preservation of the clavicular portion retains some pectoralis function if division of the insertion is required. The supraumbilical portion of the rectus abdominis muscle, based on the superior epigastric vessels, is useful for lower sternal defects but the viability of its vascular pedicle must be verified as this can be compromised by previous surgery. When used in the described fashion, these muscles will provide all the requirements for reconstruction, allowing primary repair of the chronic sternal wound when required and facilitating a rapid convalescence.

References

1. BRYANT LR, SPENCER FC, TRINKLE JK: Treatment of median sternotomy infection by mediastinal irrigation with an antibiotic solution. *Ann Surg* 1969; 169: 914–20

2. CULLIFORD AT, CUNNINGHAM JN JR, ZEFF RH, ISOM OW, TEIKO P, SPENCER FC: Sternal and costochondral infections following open-heart surgery. A review of 2,594 cases. *J Thorac Cardiovasc Surg* 1976; 72: 714–26

3. SERRY C, BLECK PC, JAVID H, HUNTER JA, GOLDIN MD, DELARIA GA, NAJAFI H: Sternal wound complications. Management and results. *J Thorac Cardiovasc Surg* 1980; 80: 861–7

4. JURKIEWICZ MJ, BOSTWICK J III, HESTER TR, BISHOP JB, CRAVER J: Infected median sternotomy wound. Successful treatment by muscle flaps. *Ann Surg* 1980; 191: 738–44

5. NAHAI F, MORALES L JR, BONE DK, BOSTWICK J III: Pectoralis major muscle turnover flaps for closure of the infected sternotomy wound with preservation of form and function. *Plast Reconstr Surg* 1982; 70: 471–4

6. NEALE HW, KREILEIN JG, SCHREIBER JT, GREGORY RO: Complete sternectomy for chronic osteomyelitis with reconstruction using a rectus abdominis musculocutaneous island flap. *Ann Plast Surg* 1981; 6: 305–14

7. HERRERA HR, GINSBURG ME: The pectoralis major myocutaneous flap and omental transposition for closure of infected median sternotomy wounds. *Plast Reconstr Surg* 1982; 70: 465–70

8. PAIROLERO PC, ARNOLD PG: Management of recalcitrant median sternotomy wounds. *J Thorac Cardiovasc Surg* 1984; 88: 357–64

9. MILLOY FJ, ANSON BJ, MCAFEE DK: The rectus abdominis muscle and the epigastric arteries. *Surg Gynecol Obstet* 1960; 111: 293–302

10. MATHES SJ, FENG LJ, HUNT TK: Coverage of the infected wound. *Ann Surg* 1983; 198: 420–9

11. MATHES SJ, ALPERT BS, CHANG N: Use of the muscle flap in chronic osteomyelitis: experimental and clinical correlation. *Plast Reconstr Surg* 1982; 69: 815–29

MARCEL J. RHEAULT, MD, FRCSC, FACS*

Pierre Masson: His Influence on the Teaching of Pathology in Canada

Pierre Masson, William Boyd, Louis Berger and Lyman Duff: these four men were responsible for the development of pathology in Canada during the first half of this century. Their influence is still important and there must be few departments of pathology in this country that do not have one or more pathologists on their staff trained by one of these physicians. They are truly the cornerstone of pathology in Canada. My paper concerns one of these men: Pierre Masson.

Masson was born on Nov. 12, 1880 in Dijon, France, in the middle of the rich vineyards of Gevrey-Chambertin. His family was one of prominent jurists and lawyers. After obtaining a licence in general chemistry and natural sciences from the science faculty of Dijon, Masson moved to Paris and became chief of laboratory at Lariboisière Hospital. In 1909, he graduated from the Faculty of Medicine, University of Paris.

From 1909 to 1919, he worked at the Pasteur Institute in Paris in the laboratory of Amédée Borrel, a microbiologist. In 1911, he became chief of laboratory at La Salpêtrière, being under the direction of Pierre Gosset, the chief of surgery. Pierre Masson was preparing his unique career in the field of pathology. Using his knowledge of the chemistry of dyes, he developed the personal techniques of staining that were to make him world renowned. On Aug. 5, 1911, he reported his first discovery: by adding saffron to hematoxylin and eosin as a third dye in the routine colorations, Masson's trichrome stain was born.[1]

Masson always processed his own specimens, cutting and staining, dissecting each cell under the microscope and making many new observations. In 1913, when he introduced his silver impregnation method for melanin using Fontana's solution, he discovered the argentaffin reaction.[2] This led to the discovery of the argentaffinity of enterochromaffin cells: the argentaffin cells. In 1914, he described the carcinoid cells of the appendix and the carcinoids. During the same year, too early for his era, he noted the existence of a diffuse endocrine gland system in the intestine. This concept was extended to other regions 24 years later by the Austrian pathologist Feyrter and half a century later, in 1969, by the British histochemist Pearse, when he proclaimed the existence of the APUD cell system. The original presentation of this discovery was given at the Academy of Sciences in Paris on Jan. 5, 1914, under the title "The intestinal endocrine gland in man".[3]

In 1914, the first world war interrupted his work. He became an army physician, was captured by the enemy and sent to Germany as a prisoner of war. After his release, he was assigned to the military hospital in Dijon and later to a military research unit near Reims. There, with René Leriche, he conducted studies on the natural history of scarring of war wounds.

FIG. 1—Pierre Masson (1880–1959).

Strasbourg Period

With the ending of the war in 1918, the provinces of Alsace and Lorraine were returned to France. From 1870 to 1918, the University of Strasbourg had been led by many illustrious German professors such as Chiari, Mönckeberg, Lobstein and von Recklinghausen. The French government, when it repossessed the university, wanted to continue its excellent academic reputation, albeit with a French touch. From all over France, the most promising physicians were chosen to fill the vacancies left by the departure of the Germans.

Masson's reputation was so great that in spite of his lack of a formal academic title, he was named chairman of the Department of Pathology and chief of the Institute of Anatomy and Pathology of Strasbourg. He was then only 37 years old, by European standards very young for such an important post.

From 1919 to 1927, he published 38 original works mainly on neuromas, carcinoids of the appendix, glomus tumours and neuronevi. In 1923, he published the first edition of his original work: *"Tumeurs" — diagnostiques histologiques".*[4] Masson's reputation spread and from various parts of the world, gifted students came to learn directly from the master the basic principles of pathology and his personal staining and processing techniques. Among those who came to work with him were Orban from Brussels, Sotero del Rio from Santiago, Chile, Prodanoff who later became director of the Institute of Pathology of Bulgaria, Famagalli from Florence, Shtull from Prague and Nicaud from Lausanne.

Presented at the meeting of the Central Surgical Association, Montreal, PQ, Mar. 14, 1985

**Professor, Department of Surgery, Hôtel-Dieu de Montréal, Université de Montréal, Montreal, PQ*

Accepted for publication Apr. 29, 1985

Reprint requests to: Dr. Marcel J. Rheault, Hôtel-Dieu de Montréal, 3840 St-Urbain, Montreal, PQ H2W 1T8

A few Canadian physicians went there to complete their training: Louis-Charles Simard who became director of the Cancer Institute of Montreal and J. Edouard Morin, member of the Royal Society of Canada and director of the Department of Pathology at St-Sacrement Hospital in Quebec. Masson's reputation was such that Abraham Flexner from the Rockfeller Foundation visited the Institute of Anatomy and Pathology of Strasbourg and asked Masson and five of his collaborators to visit the United States. France added its own recognition of his greatness; in 1923 he was created "Chevalier" of the Legion of Honour.

Montreal Period

In 1926, the University of Montreal wanted to reorganize the teaching of pathology, which until then had been unstructured and was generously done by volunteer doctors. The chairmanship of the department was offered to Pierre Masson mainly through the influence of several former students, especially Louis-Charles Simard. Why did he accept when his institute in Strasbourg was doing so well? Was it a personal mission or were there any political motives? Masson said that he received an official mandate from the French government for 3 years to organize the teaching of pathology at the University of Montreal. Thus, at 48 years of age he became professor and chairman of the Department of Pathology at the University of Montreal. He insisted on being also consulting pathologist at Notre-Dame, Hôtel-Dieu and Ste-Justine hospitals. Every morning he worked in each hospital. All the pathologists, residents and students were in direct contact with him daily. He recruited many faithful collaborators such as Louis-Charles Simard, Joseph Luc Riopelle and others.

From 1927 on, Masson published 53 papers and books. He continued his studies from Strasbourg, but also worked in new areas: on tumours of peripheral nerves, benign mesothelial tumours of serosal surfaces, cancers of the genital area of women and testicular tumours. Finally, he published what was to be his masterpiece and certainly his greatest contribution to pathology: *"Les tumeurs humaines, histologie, diagnostics et techniques"*.[5] Dr. Sidney Kobernick, a graduate of McGill University, translated the book with Masson's permission and it was published in English in 1970 by the Wayne State University Press.[6]

The quality of Masson's work and teaching was recognized by many Canadian universities. They awarded him a doctorate *honoris causa* at the University of Montreal in 1929, McGill University in 1940, Laval University in 1957 and the University of Ottawa in 1958.

Although it may be said that he did not master perfectly the language of Shakespeare, he corresponded with several leading Canadian and American pathologists: William Boyd, Lyman Duff, James Ewing, Georges Laidlaw and Arthur Purdy Stout. In 1948, he was invited by the New York Academy of Sciences to speak at a symposium on the biology of melanomas.

While Masson was the undisputed leader of the French pathologists in Montreal, his influence also extended to the anglophone sector. With one of his great admirers, F.W. Wiglesworth, professor of pathology at McGill University and pathologist in chief to the Montreal Children's Hospital, he organized many scientific exchanges with Ste-Justine Hospital. Later, one of Masson's former students, Dr. Gilles Tremblay, became professor and director of the Department of Pathology at the Royal Victoria Hospital.

Masson died on May 11, 1959, but his work has been continued by his students, all of them being admirers of a great pathologist.

His Legacy

Twenty-five years after his death, papers and biographies are still being published to his memory in French and English medical journals as testimony to the importance of his work.[7-11]

To complete this testimony, I will quote MacDermot from his history of the first 100 years of Canadian medicine.[12]

> One of the most distinguished histopathologists of his time, Professor Masson has carried international fame with his work on tumours of the nervous system, along with many other contributions in pathology; his histopathological techniques, particularly his trichrome stain, are familiar in all pathological laboratories.

I cannot omit that superb statement of Sidney Kobernick in his introduction of Masson's traduction: "Masson's approach represents a lost art both in technique and observation."

William Boyd, in 1956, speaking at Lyman Duff's funeral, said: "Canadians do not have the 'giants' in medicine."[13] Looking back 25 years after the death of Pierre Masson and acknowledging his enduring influence on pathology, I would argue with Boyd's opinion. I have had the privilege to meet and work with Pierre Masson who was indeed a giant of medicine.

References

1. MASSON P: Le safran en technique histologique. La Société de Biologie, Paris, avril 1911
2. Idem: Imprégnation argentique du pigment. *CR Soc Biol* 1913; 75: 210
3. Idem: La glande endocrine de l'intestin chez l'homme. *CR Acad Sci (Paris)* 1914; 158: 59–61
4. Idem: *Tumeurs — diagnostics histologiques*, Maloine, Paris, 1923
5. Idem: *Tumeurs humaines, histologie, diagnostics et techniques*, 2e éd, Maloine, Paris, 1956
6. Idem: *Human Tumors; Histology, Diagnosis, and Technique*, 2nd ed, Wayne St U Pr, Detroit, 1970
7. RIOPELLE JL: [To the memory of Professor Pierre Masson, 20 years later.] *Union Med Can* 1979; 108: 473–6
8. CADOTTE M: L'héritage scientifique du Professeur Pierre Masson. *Union Med Can* 1984; 113: 344–5
9. MICHALANY J: Masson's contribution to pathology and to histological technique. *Ann Pathol* 1983; 3: 85–93
10. CABANNE F: [Pierre Masson. A precursor and rediscoverer (1880–1959).] Ibid: 95–7
11. SEEMAYER TA: The life and legacy of Professor Pierre Masson. *Am J Surg Pathol* 1983; 7: 179–83
12. MACDERMOT HE: *One Hundred Years of Medicine in Canada, 1867–1967*, McClelland and Stewart, Toronto, 1967: 193
13. BOYD W: Medical research in Canada. In ibid: 194

BOOKS RECEIVED
continued from page 411

Management of Spinal Deformities. Orthopaedics 2. Edited by Robert A. Dickson and David S. Bradford. 331 pp. Illust. Butterworth & Co. (Publishers) Ltd., Boston, 1984. $39.95 (US). ISBN 0-407-92347-X.

Mastery of Surgery. 2 vols. Edited by Lloyd M. Nyhus and Robert J. Baker. 1566 pp. Illust. Little, Brown and Company, Boston, 1984. Price not stated. ISBN 0-316-61742-3 (2 vol. set).

Maxillofacial Injuries. 2 vols. N.L. Rowe and J.L1. Williams. 1030 pp. Illust. Churchill Livingstone, Edinburgh; Academic Press Canada, Don Mills, 1985. $273. ISBN 0-443-01509-0 (2 vol. set).

Norris and Campbell's Anaesthetics, Resuscitation and Intensive Care. 5th ed. Donald Campbell and Alastair A. Spence. 261 pp. Illust. Churchill Livingstone, Edinburgh; Academic Press Canada, Don Mills, 1978. $20, paperbound. ISBN 0-443-01573-2.

Operative Perinatology. Invasive Obstetric Techniques. Edited by Leslie Iffy and David Charles. 1084 pp. Illust. Macmillan Publishing Company, New York; Collier Macmillan Canada Inc. Toronto, 1984. $157.50. ISBN 0-02-359500-0.

Organ Transplantation in Diabetics. Proceedings of the International Symposium on Organ Transplantation in Diabetics, September 1-2, 1983. The Hague, The Netherlands. A Transplantation Proceedings Reprint June 1984. Edited by Reinout van Schilfgaarde, Guido G. Persijn and David E.R. Sutherland. 309 pp. Illust. Grune & Stratton, Inc.; Academic Press Canada, Don Mills, 1984. $79.50. ISBN 0-8089-1685-8.

Principles and Practice of Surgery. A Surgical Supplement to Davidson's Principles and Practice of Medicine. A.P.M. Forrest, D.C. Carter and I.B. Macleod. 672 pp. Illust. Churchill Livingstone, Edinburgh; Academic Press Canada, Don Mills, 1985. $46.50, paperbound. ISBN 0-443-01565-1.

Progress in Surgery. Volume One. Edited by I. Taylor. 225 pp. Illust. Churchill Livingstone, Edinburgh; Academic Press Canada, Don Mills, 1985. $35, paperbound. ISBN 0-443-93117-7.

Regional Anesthesia. Techniques and Clinical Applications. Harold Carron, Gregg A. Korbon and John C. Rowlingson. 198 pp. Illust. Grune & Stratton, Inc., Orlando, Fla.; Academic Press Canada, Don Mills, 1984. $56.25. ISBN 0-8089-1654-8.

continued on next page

continued from page 390

himself as an administrator, clinician, teacher and researcher, Downs has been an active member and held offices in several medical societies and was a founder of the Canadian Society for Vascular Surgery. Known for his expertise in vascular research, he also served as external referee for the Medical Research Council and the Canadian Heart Foundation projects.

In recognition of the contribution of Downs to the Department of Surgery, the department's research committee established the Allan R. Downs Lecture to be delivered annually during the surgical research symposium at the University of Manitoba.

Trauma in Hawaii in January: Surgical Society Beckons

While hundreds of surgeons suffer the trauma of another Canadian winter, some of their colleagues — members of the Pan-Pacific Surgical Association — will be learning about how to manage the victims of trauma and, in their spare time, will be soaking up the sunshine or sightseeing in Hawaii.

The meeting, which is the 18th in a series of congresses, will be held Jan. 11 to 17, 1986. It will feature plenary sessions with trauma experts from the United States, Canada, Japan, Australia and Korea as well as smaller groups, focusing on trauma from the point of view of obstetrics and gynecology, general surgery, thoracic and cardiovascular surgery, plastic surgery, ophthalmology, orthopedic surgery, otolaryngology, urology, and neurosurgery as well as anesthesiology.

Chornell: Join us in Hawaii.

The president of the Canadian chapter of the association, J. Gary Chornell, an ophthalmologist in Edmonton, is urging all Canadian surgeons to join the association in time to attend the upcoming congress. The association is committed to improving medical and surgical care in the Pacific basin countries and, to this purpose, manages an endowment fund that is used for temporary placement of certificated surgeons in countries requesting assistance or for continuing education for surgeons from isolated developing countries in the basin. Currently, the association numbers about 3000, mostly from the United States, and Chornell, who also is vice-president for Canada on the executive of the parent association and, at 42, is the youngest to have held the job, is hoping that at least 200 Canadians will find out what a contradiction in terms Hawaii and trauma are.

AMY CHOUINARD

BOOKS RECEIVED cont'd

Septic Shock. Contemporary Issues in Infectious Diseases. Vol. 4. Edited by Richard K. Root and Mele A. Sande. 281 pp. Churchill Livingstone, Edinburgh; Academic Press Canada, Don Mills, 1985. $61. ISBN 0-443-08397-5.

Silvergirl's Surgery. Biliary Tract. Edited by James O. Robinson. 233 pp. Illust. Silvergirl, Inc., Austin, Tex., 1985. $55.(US) (clothbound); $19.(US) (paperbound). ISBN 9-941432-14-9.

Surgical Care II. Robert E. Condon and Jerome De Cosse. 431 pp. Illust. Lea & Febiger, Philadelphia, 1985. $85.75. ISBN 0-8121-0931-7.

Surgical Pathology of the Head and Neck (in two volumes). Edited by Leon Barnes. 1866 pp. Illust. Marcel Dekker, Inc., New York, 1955. Price not stated. ISBN 0-8247-7216-4 (vol. 1); ISBN 0-8247-7269-5 (vol. 2).

Taylor's Principles and Practice of Medical Jurisprudence. 13th ed. Edited by A. Keith Mant. 415 pp. Illust. Churchill Livingstone, Edinburgh; Academic Press Canada, Don Mills, 1984. $85.75. ISBN 0-443-01481-7.

Le traitement de la recto-colite ulcéro-hémorragique. Rapport présenté au 86e congrès français de chirurgie, Paris, 24 au 27 Septembre 1984. Monographies de l'Association française de chirurgie. Ph. Bérard et R. Parc. 93 pp. Illust. Masson, Paris, 1984. Prix non mentionné, broché. ISBN 2-225-80365-X.

Tumors of the Kidney and Urinary Tract. Color Atlas and Textbook. Steen Olsen. 291 pp. Illust. Munksgaard International Publishers Ltd., Copenhagen, 1984. Price not stated. ISBN 87-16-09040-3.

SESAP IV Critique

ITEM 247

The densities and air fluid levels in the pleural space indicate that the patient has developed a significant empyema. Inflammatory reaction that has reached this stage of organization cannot be resolved by antibiotics alone. Multiple additional chest tubes would probably be of little value. Instillation of enzymes via the chest tube is ineffective, and may contribute to recurrent or continuing air leak. Instillation of antibiotics into the chest tube would be of value only in the area served by the tube. If the chest tube is not functioning, antibiotics would not be distributed throughout the pleural cavity. This patient has several of the indications for operation. These criteria include multiple air fluid levels, failure of tube thoracostomy, and a protracted worsening febrile course. The patient is an ideal candidate for thoracotomy and evacuation of the preural cavity. Although not decortication in the strict sense, this term has often been used to describe the procedure. Recovery from the operation is rapid.

C

Reference

247/1. Collins MP, Shuck JM, Wachtel TL: Early decortication after thoracic trauma. Arch Surg 113:440-445, 1978